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ECONOMIC AFFAIRS

ENERGY: STATUS AND DEVELOPMENT--46

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3 February 1986

CHINA REPORT
ECONOMIC AFFAIRS
ENERGY: STATUS AND DEVELOPMENT -- 46

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NATIONAL POLICY

REPORT OUTLINES ENERGY CONSUMPTION PATTERNS BY YEAR 2000

HK230337 Beijing JINGJI RIBAO in Chinese 9 Nov 85 p 3

[Article by Lin Hanxiong [2651 3352 7160] and Wang Qingyi [3769 1987 0001] of the "China's Energy Sources in the Year 2000" Research Group: "China's Energy Sources in the Year 2000"]

[Text] The 12th CPC Congress has listed economic development as the main strategic point in our work. What are the prospects for China's energy in the year 2000? What are the factors which restrict the development of China's energy? What kind of development strategy and policy measures should we adopt? This article gives a brief analysis of the above questions according to the results of some concerned experts' research on China's energy sources in the year 2000.

The Situation of China's Energy Sources in the Year 2000.

In the year 2000, China's energy sources will have the following characteristics: Energy sources will be rich in quantity and variety, but annual per capita energy will still be low and energy distribution will be unbalanced; China's economic structure and social life will still be based on its own energy sources, and the export and import of energy will remain a small proportion of energy consumption; China will still be one of the few countries in the world whose energy sources are chiefly coal, and this situation will increase the difficulties in developing, transporting, and utilizing energy; there will be a sharp increase in the demand for energy in rural areas, the demand for commodity energy will surpass the energy supply, and we will have to develop various small-scale energy technologies which are suitable for use in different local areas; we will be the third largest energy-consuming country in the world, but annual per-capita energy consumption standard will still be low, and the standard of energy consumption in people's daily life will be even lower, so we will have to look for a comfortable lifestyle which not only consumes less energy but also conforms with national tradition. Finally, our standard of energy consumption in unit energy output value will be high and energy waste will be serious, so we will have a great potential in energy conservation. All these characteristics are our starting points in making our energy policies and plans.

According to the estimates of the experts, China's demand for energy by the year 2000 may be calculated in the following two ways: First, considering the possible changes in the economic structure, the technological progress to be made and the possible energy saving capability as well as other factors, and in order to realize the quadruplication of our agricultural and industrial output value and enable our people to live a comfortable life, China's demand for energy will increase to 1.56 billion tons of standard coal by the year 2000. This figure is calculated according to the departmental analysis method. Second, figuring that the elastic coefficient is 1, by the year 2000, China's energy demand will double, namely, 2.4 billion tons of standard coal; and then by deducting 0.3 billion tons of standard coal and 0.4 billion tons of standard coal, which are respectively the possible technological energy conservation and the possible structural energy conservation. China's demand for energy by the year 2000 will increase to 1.7 billion tons of standard coal.

According to the estimates of the relevant departments and experts, by the year 2000, China's one-time energy supply capability will increase to 1.3-1.48 billion tons of standard coal.

According to the above estimates, the gap between demand and production will be 15-20 percent on average--a wider gap than at present, with 0.4 billion tons of standard coal as the maximum gap, 0.08 billion tons of standard coal as the minimum gap and 0.22 - 0.26 billion tons of standard coal as the intermediate gap. This situation will probably emerge by the year 2000.

There will be major changes in the distribution of energy production and consumption areas. The general trend is that as the energy production centers move westward, east China will increasingly suffer energy shortages. By the year 2000, Shanxi and Nei Monggol are expected to produce two-thirds of the new increases in total coal output of the whole country. Shanxi Province will be able to transfer 300 million tons of coal to other parts of China. So transporting Shanxi coal to other parts of China will become a question which affects the overall situation. Within this century, major petroleum producers will remain in east China, though offshore oil resources and those in west China are promising. The petroleum-processing industry will gradually move from northeast to central, south, and southwest China. By the end of this century, there will be seven big regional electric power networks in China, of which the power networks in central, central-south, and south China will become basically self-sufficient, while thermal and hydroelectric power will be transmitted over long distances and through ultra-high tension power lines from north and central China to the grids in east and northeast China, where nuclear energy will be developed.

There will be fundamental development in China's energy technology. By the end of this century, China's technology in developing and utilizing energy, its technology of energy equipment, its energy self-supporting capability, as well as its capability to develop and rely on its own energy technology will have reached the standard of the advanced countries at the end of 1970's and the beginning of 1980's and will probably have reached an even higher standard in some aspects.

The Major Problems in the Development of China's Energy Sector

1. The shortage of funds and lack of time. The shortage of investment is obviously the major restrictive factor. What is more, the construction of large energy projects generally takes approximately 10 years, and the period for effective investment should be before 1995, so time is limited.
2. The influence of the change in the distribution of energy production and consumption areas. The westward movement of development centers of coal, hydroelectric power and other kinds of energy will have a great impact on energy transportation, regional economic development, and social development. This will probably widen the gap between the rich and poor regions.
3. The new technological revolution will challenge energy. Energy research will develop rapidly throughout the world. China's energy technology lags about 30 years behind advanced world standards. Because of the fast development of the new world technological revolution, the gap between China's energy technology and the advanced world standards will probably widen and the competitiveness of China's energy products on the international market will probably be weakened.
4. The social and environmental restrictions. The outstanding problems are: the issue of the source of coalminers; the question of energy projects and the question of appropriating land; and the question of environmental pollution caused by the burning of coal.
5. The question of comfortable lifestyle with a low annual per-capita energy consumption. According to analysis and research conducted by foreign and domestic experts, an annual per-capita output value of \$1,000 entails an annual per-capita energy consumption of 1.5 tons of standard coal, whereas China will only be able to supply 1 ton per capita annually by the year 2000. So it is of primary importance to explore a consumption structure and a lifestyle which consumes less energy.

Proposal for Energy Development Strategy and Energy Development Policies

The premise of our energy development strategy should be to improve the quality of our people's life, lay equal stress on developing and conserving energy, produce sufficient energy in order to develop the economy and improve the living standards, form an energy system whose distribution is rational and efficiency of development and utilization is high, and reduce the impact on the ecological environment.

With the above guiding ideology in mind, we put forward the following policy proposals:

1. To improve the energy structure. To improve the energy structure is vital to the increase of social economic results. The main measures should be to accelerate the development of hydroelectric power, nuclear energy, and natural gas, and properly reduce the proportion of the small coal industry.

Since China is rich in hydroelectric resources, accelerating the development of hydroelectric power is the most practical way to improve our energy structure.

2. To improve the administrative structure of the energy sector. First of all, we must further relax our policies, make full use of local resources, implement the policy of having all sides contribute to the development of energy, and bring into full play the enthusiasm of all sides. At present, we should encourage all sides to develop electric power.
 3. To adjust the energy prices as soon as possible. The reform of the prices of industrial products should begin with adjusting energy prices. The principle in deciding the prices of energy products is to make the price nearer to the value and take into consideration the relation between supply and demand and the factor of foreign trade.
 4. To widely open up channels to pool funds for the development of the energy sector. In the next few years, it will be necessary and practical for us to implement the policy of "slant investment" in the development of the energy sector. In the meantime, we must widely open up channels to pool funds for the development of the energy sector and should encourage various areas to use local funds to first develop the energy sector. We should also make use of the accumulated huge capability of the energy industry itself to establish our energy construction funds so as to ensure stable supply of the energy development funds. We should also levy a tax on energy consumption to make up for the insufficient energy development funds and levy a surtax on energy which restricts consumption, so as to make up the funds for energy conservation.
- We should actively invite foreign investment in various and flexible ways according to our domestic capability to produce complete sets of equipment and our repayment capability.
5. To establish a strong leadership in charge of energy conservation. Since the work of energy conservation has become increasingly difficult, we must establish a unified leadership, change the multi-level leadership into a unified one, and change the decentralized control into a unified one. We suggest establishing leading groups and relevant organizations under the State Council to administer the work of saving energy in the whole country in a unified way. We must also strengthen our propaganda work.
 6. To pay great attention to the question of energy conservation in rural areas. First, we should grow more trees and grass in rural areas and encourage the people to use cooking stoves which consume less firewood. The development of fuel forests must be listed in plans of forestry departments. Concurrently, we must actively develop small coalmines and small hydroelectricity production, develop and make use of new forms of energy tailored to local conditions, and develop highly functional light machinery driven by man or animal power.

7. To improve the method of utilizing coal and reduce environmental pollution. We must improve our method of burning coal and use coal comprehensively. This is the key to raising the efficiency of utilizing energy sources and reducing energy pollution.

8. To greatly strengthen energy research and education. The scientific research on energy should center on digesting and absorbing imported technology. We must attach equal importance to soft science and hard technology in the reform of the scientific research system and in tackling key problems by means of cooperation.

In energy education, we suggest that all the universities of communications set up departments or faculties of energy sources. In the meantime, we must strengthen intermediate technological education and in-service training. We should also extensively publicize popular science and energy.

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CSO: 4013/43

NATIONAL POLICY

LI PENG CONGRATULATES POWER MINISTRY ON 1985 ACHIEVEMENTS

OW311012 Beijing XINHUA in English 0956 GMT 31 Dec 85

[Text] Beijing, 31 Dec (XINHUA)--China's thermal and hydro-electric power producers added a combined generating capacity of 6,100 MW this year, a record high, the Ministry of Water Resources and Electric Power said here today.

The new generating units that have gone into operation are installed in power stations and plants mostly located in the eastern part of the country, which is more economically developed and yet has an acute shortage of power supply, the ministry said.

With a national generating capacity of 86,200 MW, China expects to produce a total of 406 billion KWh of electricity this year, the last year of the Sixth Five-Year Plan (1981-1985), about 40 billion kWh more than the target set for the year. While congratulating the ministry on what it has achieved this year, Vice-Premier Li Peng stressed that power supply would remain strained in China for a fairly long period of time, adding that more arduous work was ahead.

Beginning next year, Minister Qian Zhengying of Water Conservancy and Electric Power said that apart from intensifying the construction of some large power projects by the central government, the provinces themselves would raise more funds for their power undertaking.

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CSO: 4010/26

NATIONAL POLICY

NATION'S ENERGY OUTPUT REGISTERS STEADY INCREASE

OW111437 Beijing XINHUA Domestic Service in Chinese 1302 GMT 9 Oct 85

/Article by reporters Xu Yaozhong and Huang Fengchu/

/Text/ Beijing, 9 Oct (XINHUA)--Good news about China's energy production this year has continued to pour in: The total energy output from January to September is equivalent to 620 million tons of standard coal, an increase of 10.8 percent over the same period last year, or approximately equal to the output for all of 1978. The country's coal reserves for power generation have grown substantially. The task of ensuring an installed capacity of 5 million kilowatts of electricity this year is proceeding smoothly, and oil exploration has moved from land to sea with good preliminary results.

According to the departments concerned, China's current energy production has three distinctive traits:

1. A steady increase in the production of coal, electric power, and oil. During the first 9 months this year, raw coal production grew by 11.5 percent, crude oil by 10 percent, and electric power by 8.7 percent, as compared with the same period last year. Such high growth rates have been rare in recent years. Moreover, growth has been relatively balanced, with a monthly increase of around 10 percent.
2. Large, medium, and small units took off simultaneously. While coal mines operating directly under the Ministry of Coal Industry steadily increased their production, medium and small coal mines at the local level have also sharply raised production, with output in the first 9 months already having exceeded 310 million tons. Currently accounting for one-fourth of the country's total coal production, China's 60,000 or more town and village coal mines played an effective role in easing the bottleneck in the supply of coal. Fully mobilizing the enthusiasm of all sectors, the power industry departments have adopted a method whereby the state, the collective, and the individual are all engaged in running power stations. The country now has some 70,000 small hydropower stations, or "luminous pearls" as some people call them, with a total capacity of more than 20 billion kilowatt-hours.
3. New facilities constructed along with the expansion and renovation of the old ones, and the tapping of their potential. This year's high growth rates

may be attributed to increased production capacity brought on by capital construction, and to the renovation of old enterprises and the tapping of their potential. The Petroleum Department's increase of some 7 million tons of oil-extraction capacity in the first 7 months of this year came mainly from the renovation and expansion of old oil fields.

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CSO: 4013/33

NATIONAL POLICY

HEILONGJIANG 1979-1984 ENERGY PRODUCTION REVIEWED

SK070902 Harbin HEILONGJIANG RIBAO in Chinese 21 Oct 85 p 1

/Text/ According to the data provided by the provincial Statistics Bureau, energy construction has been accelerated in our province over the past few years. Energy production has been changed from a standstill to sustained and stable growth, and a good situation unprecedented for many years has appeared.

According to statistics, the province's investment in such energy construction as power, coal, and petroleum from 1979 to 1984 amounted to 77.7 percent of the total for the 26 years before the 3d Plenary Session of the 11th CPC Central Committee, and was 41.4 percent of the total investment for the entire industry in the same period. During that period, the newly added capacity of power generating equipment was 1,462,600 kilowatts, of oil exploitation 7.03 million tons, and of coal mining 4.467 million tons.

Raw coal output in 1984 reached 56.798 million tons, a 53.1-percent increase over 1978. From 1979 to 1984, local collieries produced a total of 60.432 million tons of raw coal, accounting for 21.7 percent of the total raw coal output produced by the province during the same period.

In 1984, electricity output was 17.62 billion kWh, a 63.6-percent increase over 1978. This helped alleviate to a certain extent the strained power supply of our province.

After 1976, when crude oil output broke the record of 50 million tons, a new development technique of early-stage stratified water injection was adopted to bring the annual output up to more than 50 million tons for 9 years in succession. In 1984 output reached 53.564 million tons.

In 1984 the province saved energy equivalent to 1.74 million tons of standard coal. Of the sum, 760,000 tons were saved through technical transformation, amounting to 43 percent.

From January to September this year the output of raw coal, crude oil and electricity showed an increase of 8, 3.2 and 6.4 percent, respectively, over the same period last year, thus maintaining the good trend of stable growth. However, energy production is still a weak link in the national economic development of our province. In the future, while continuing energy construction at a quicker pace, all localities should try by all means to conserve energy.

POWER NETWORK

NORTHEAST LAYING FOUNDATION FOR EXPECTED BOOM BY YEAR 2000

OW051931 Beijing XINHUA in English 1550 GMT 5 Dec 85

[Text] Xian, 5 Dec (XINHUA)--China's vast northwest region is expected to generate 32.5 billion kilowatt-hours of electricity this year, up 30 percent from 1980.

Power output will be 520 kWh per capita in the 3.2 million sq km area, which covers Shaanxi, Gansu, and Qinghai provinces, and the Xinjiang Uygur and Ningxia Hui Autonomous Regions.

This is 30 percent higher than the national average, an official of the Northwest China Power Administration said here.

Since 1981, the area's power output has risen at an annual average of 5.3 percent. The official attributed the increase to state investment of 3 billion yuan in the industry during that period.

As a result, northwest China, which suffered from a power shortage before 1980, began supplying 1.4 billion kWh of electricity annually to other parts of the country starting from 1982.

Five large thermal power plants with a total generating capacity of 1.15 million kilowatts have gone into operation in Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang over the past 5 years.

Three power transmission lines of 110,000, 220,000, and 330,000 volts have been erected from Qinling to Xingping, both in Shaanxi, from Tongchuan in Shaanxi to Qingyang in neighboring Gansu, and from Jingyuan in Gansu to Gucheng in Ningxia. The lines total 466 kilometers in length.

Top Chinese leaders Hu Yaobang and Zhao Ziyang have urged the local authorities to speed construction of the power industry to pave the way for a spurt in economic growth around the turn of the century when the country's focus of economic development will be shifted to northwest China.

The area's water power potential is estimated at 84 million kW, the official said. He added that only about 3 percent has been developed so far. Coal reserves in the area have been verified at 140 billion tons.

The 1.28 million kW Longyang Gorge hydroelectric power station is being built on the Huang He in Qinghai Province. The 800,000 kW Ankang station is also under construction on the Han Jiang in Shaanxi Province.

Over the next 5 years, Shaanxi will build two large thermal power plants and Gansu another two. Qinghai will build the Lijia Gorge hydroelectric power station, also on the Huang He. They will have a total generating capacity of 6 million kilowatts.

With the completion of these projects, northwest China will become one of the nation's biggest energy bases, which will be able to supply 9 billion kWh a year to Beijing alone, the official said.

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CSO: 4010/20

POWER NETWORK

NEI MONGGOL RAPIDLY DEVELOPS POWER INDUSTRY

SK181237 Hohhot NIEMENGGU RIBAO in Chinese 2 Dec 85 p 1

[Text] During the Sixth Five-Year Plan period, along with the rapid development of the power industry, the region has provided more and more energy resources for industrial and agricultural production and the people's livelihood.

So far, the region has 82 power plants with a generating capacity at or above 500 kW. The total installed capacity of these powerplants has reached 2,232,000 kW. It is expected that the region's total installed capacity will reach 2,432,000 kW by the end of this year, an increase of 105 percent over the 1980 figure of 1,183,000 kW. During the Sixth Five-Year Plan period the yearly average increase rate of the installed capacity has been 15.5 percent.

From 1981 to last November, such generating sets have successively put into operation as a 100,000-kW generating set of the first Baotou thermal power plant, two 25,000-kW generating sets of the Wuda power plant, two 25,000-kW generating sets of the Zhalainuoer power plant, a 200,000-kW generating set of the Tongliao power plant, and a 600,000-kW generating set of the Yuanbaoshan power plant. The second 200,000-kW generating set of the Tongliao plant is expected to be put into operation by the end of [1985]. The region's total generating capacity at that time may reach 7.8 billion kWh, an increase of 2.9 billion kWh over 1980. Over the past 5 years the region has set up about 2,000 km of transmission lines at or above 35,000 kV and 24,000 kV transformer substations with a total capacity of 550,000 kV respectively showing increases of 21 percent and 27.5 percent over 1980.

Since 1981 the rural and pastoral areas in our region have made rapid progress in power construction. Today, 82 of the 89 banners and counties in the region have electric circuits installed. By the end of this year the total power consumption of the region's rural and pastoral areas may reach 1.36 billion kWh, an increase of 55.6 percent over 1980. The 110 kV transmission line with a total length of 160 km between the Zhalainuoer power plant and Hailaer traverses the Hulun Buir grasslands. Three 110 kV

transmission lines with a total length of 300 km have been built in East Xin Barag Banner and West Xin Barag Banner of Hulun Buir League and Siziwang Banner of Ulanqab League. Over the past few years the region has applied scientific research of using wind power to generate electricity and has entered a new stage of extensive popularization of wind power. By the end of last October, the region had more than 10,000 wind-driven generators. Sixty percent of the herdsmen in Wulan Sumu, Urad Middle Banner of Bayannur League, have installed wind-driven generators, ranking Sumu in first place nationally.

Through large-scale technological transformation and the renewal of equipment, the Nei Monggol power grid has enhanced its safe operation. The occurrence of accidents comes down every year. During the Sixth Five-Year Plan, the power plants of the Nei Monggol power grid have saved 149,000 tons of coal and 140,000 kWh of electricity. From 1981, taxes and profits handed over to the state by Nei Monggol Power Administrative Bureau increased year by year, exceeding 100 million yuan for 2 years in succession.

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CSO: 4013/48

SHANXI POWER INDUSTRY DEVELOPS QUICKLY

Taiyuan SHANXI RIBAO in Chinese 1 Oct 85 p 3

[Article: "The Power Industry in Shanxi Is Developing at a Gratifying Pace --The Amount of Power Now Generated in One and One-Half Days Exceeds the Amount Generated in Over a Year Shortly After the Nation Was Founded"]

[Text] According to the Shanxi Province Electric Power Industry Bureau, Shanxi's electric power industry has relied on its enormously thick coal deposits, and the development situation is pleasing. Shanxi generated 11.99 billion kWh in electricity from January through August of 1985, up by 10.7 percent over the same period in 1984. Total installed generator capacity now has reached 3.267 million kW. Power generation, supply and utilization in Shanxi now have been outfitted fully to form a unified power network that is linked to the North China Grid.

The electric power industry in Shanxi began in 1908. Total installed generator capacity was only 39,000 kW at the time China was liberated and annual power output was 63.29 million kWh. The electric power industry in Shanxi Province has developed quickly in the 30-plus years since the PRC was founded. We have built a total of 14 large and medium-sized power plants (stations) like the Taiyuan No 1 and No 2 thermal power plants, the Datong Pingshan power plant, the Niangziguan power plant and others with a total of 57 installed generator sets. Some 3.148 million kW in additional capacity has been added and power output capacity is 81.3 times the pre-liberation figure. Total power output in 1984 reached 16.73 billion kWh, up by 263 times over 1949. The amount of power now generated in one and one-half days is greater than the amount generated in an entire year shortly after the nation was founded.

The increased amounts of electric power equipment have led to the gradual formation of Shanxi's power network. The 10-plus small power plants in Shanxi before liberation operated independently and had only 12 kilometers of 35 kV power transmission lines. They bore no resemblance to a power network. A 220 kV backbone power network now has taken shape in Shanxi, a 110 kV network extends throughout the province and it is criss-crossed with 35 kV lines. There now are 13,704 kilometers of power transmission lines and 401 transformer stations scattered about, with a primary transformer capacity of 5.683 million volt/amps.

Shanxi's small thermal power and hydropower plants (stations) dovetail with large and medium sized power stations and play their own role. They have made an important contribution to rural power development throughout the province. Full connection of all the counties in Shanxi was achieved in 1978 and every township was connected in 1983, and 82.4 percent of rural areas have electricity. Total electricity use in agriculture in Shanxi in 1984 was 1.73 billion kWh and average electricity use per capita for the agricultural population reached advanced levels in China.

There have been further developments in Shanxi's electric power industry since the Third Plenum of the 11th CPC Central Committee. We have built and expanded the Shentou, Niangziguan, Datong No 2 and other power plants, and installed capacity has reached 1.24 million kW, equal to one-third of installed generation capacity in Shanxi, and power output has grown by 58 percent. The Datong No 2 power plant, the Shentou power plant, the Zhangze power plant, the Jinjing 500 kV transmission and transformer project and other key state projects now are under construction. Four new generator sets will be installed this year with a capacity of 700,000 kW, which is the highest of any province, municipality or autonomous region in China. Total installed generator capacity during the Sixth Five-Year Plan was 1.425 million kW. Additional generators with a capacity of 2.7 million kW will be installed in Shanxi's thermal power base area during the Seventh Five-Year Plan to complete a nationally important thermal power base area with a capacity of 7 million kW.

12539/12955

CSO: 4013/24

POWER NETWORK

JILIN DEVELOPS HYDROELECTRIC, THERMAL POWER PROJECTS

SK070218 Changchun Jilin Provincial Service in Mandarin 1030 GMT 6 Dec 85

[Text] During the Sixth Five-Year Plan, Jilin has rapidly developed hydroelectric power projects and witnessed an upward trend in the development of thermal power projects. The first-stage project of the Baishan hydroelectric power station has the greatest capacity in the northeast region. At present three power generating units have been put into production with a total capacity of 900,000 kW. The province's total installed capacity of hydroelectric power stations in the past 5 years was 1.2 times that of the early Sixth Five-Year Plan, and annual power output increased by 2.2 billion kWh.

In order to further ease the province's strained power supply situation, this year we initiated and prepared for construction for thermal power projects with a total installed capacity of 1.4 million kW. By the end of October, some 60 million yuan had been invested in these four thermal power construction projects, accounting for 60.4 percent of the annual plan--the greatest investment in thermal power projects our province has ever made in a year.

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CSO: 4013/48

POWER NETWORK

YUNNAN'S HUGE POTENTIAL BARELY TAPPED

OW310138 Beijing XINHUA in English 1131 GMT 30 Dec 85

[Text] Kunming, 30 Dec (XINHUA)--Yunnan Province is gearing up to become a major electricity supplier for southern China and other parts of Southeast Asia, a provincial official here said.

Li Degang, director of the provincial electric power bureau, said that over the past 5 years, the province's designed capacity of power generation had increased from 1,060,000 to 2 million kilowatts.

Another five hydroelectric and thermal power plants are now under construction with a combined capacity of 2,950,000 kilowatts.

Li said the largest of the province's seven present thermal power stations, Xiaolongtan, had a total design capacity of 600,000 kilowatts.

He said that verified coal deposits totalled 16.7 billion tons in the province.

Of Yunnan's 600 rivers, the six largest were estimated to have a generating capacity of 71,160,000 kilowatts, and more than 70 percent of this was believed to be exploitable.

Li added that the province's generating capacity was expected to reach 5.43 million kilowatts by the end of the century.

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CSO: 4010/24

POWER NETWORK

BRIEFS

DATONG-BEIJING 500KV PROJECT--Beijing, 6 Dec (XINHUA)--The 500 kV transmission and transformer project from Datong, Shanxi, to Fangshan, Beijing, went into operation on 6 December. Qian Zhengying, minister of the Ministry of Water Resources and Electric Power, personally turned on the electricity in the main control room of the Beijing Fangshan 500kV transformer station. Suddenly, a powerful current was transmitted to the Beijing-Tianjin-Tangshan areas through the Datong-Beijing 500kV transmission lines and the Fangshan Transformer Station from the Datong energy base in Yanbei Prefecture, Shanxi. This will play an important role in easing the shortage of power in the Beijing-Tianjin-Tangshan area. [Summary] [Beijing XINHUA Domestic Service in Chinese 1227 GMT 6 Dec 85 OW] /9738

ANHUI POWER INDUSTRY--Anhui's power industry made headway in the Sixth Five-Year Plan period. Establishment of new power plants and expansion of existing ones resulted in an additional 700MW in generating capacity. This, plus the original generating capacity, brought the province's total capacity to 2,491,800 kW. A high-tension 500kV power transmission line was erected between Huainan and Fangchang. During this 5-year period, power output averaged 56.35 billion kWh per quarter. Profit turned over to the state by the power industry totaled 548,647,000 yuan for this period. [Summary] [Hefei Anhui Provincial Service in Mandarin 1100 GMT 10 Dec 85 OW] /9738

GUANGDONG-GUANGXI 200KV GRID--Guangxi is now supplying power to the Zhaoqing (Baizhu) transformer station via the Guangdong-Guangxi 200kV power grid. Guangxi can now supply Guangdong with 1.2 million kilowatt-hours of power a day. This will help ease the province's power shortage. The power line runs to Zhaoqing from the Cangwu County transformer station in Guangxi. It is hoped that Guangxi's power supply to Guangdong will increase to 100,000 kilowatts when the wet season arrives. [Summary] [Guangzhou Guangdong Provincial Service in Mandarin 0400 GMT 15 Dec 85 HK] /9738

GUANGDONG EXPANSION PLANS--Zhan Xinquan, deputy director of the Provincial Electric Power Industry Bureau, said when interviewed by reporters that Guangdong plans to increase its installed generating capacity by some 3 million kilowatts during the Seventh Five-Year Plan, equivalent to the total increase during the previous three five-year plans. Apart from the Daya Bay nuclear power station, eight power stations will be completed during

the period of the plan. These are Shajiao A and B; the expansion of the Huangpu power plant; Guangzhou, Shantou, and Haikou power plants; and the (Changhan) and Baigou hydroelectric stations. The completion of these facilities will do much to ease the power shortage in the province. Guangdong will also start work on constructing or expanding nine other power plants with a total installed generating capacity of 2 million kilowatts. Some of these will go into operation during the period of the plan. The province also plans to build 800 kilometers of 200kV transmission lines and 100 kilometers of 500kV transmission lines, and to construct twelve 220kV transformer stations. [Summary] [Guangzhou Guangdong Provincial Service in Mandarin 0400 GMT 29 Dec 85 HK] /9738

XINJIANG'S GROWING CAPACITY--By the end of this year, Xinjiang's installed generating capacity will be 1.21 million kilowatts, of which 373,000 were added during the Sixth Five-Year Plan. The region will generate 3.8 billion kilowatt hours this year, an increase of 1.44 billion kWh over 1980. [Summary] [Urumqi Xinjiang Regional Service in Mandarin 1300 GMT 29 Dec 85 HK] /9738

YUNNAN POWER INDUSTRY GROWTH--The electric power industry in Yunnan Province developed very quickly during the Sixth Five-Year Plan. The gross installed capacity of the electric power system in the province is now 1.26 million kilowatts. The province's electricity output this year will reach 5.64 billion kilowatt-hours. The gross installed capacity of small hydropower stations is some 553,000 kilowatts. These figures are 19, 24, and 30 percent higher respectively than in the Fifth Five-Year Plan. The electric power grid of the provincial electric power system with Kunming as the center, which includes 3,700 kilometers of transmission lines of over 35 kV, can exchange electric power with Sichuan and Guizhou provinces. [Summary] [Kunming Yunnan Provincial Service in Mandarin 2300 GMT 28 Dec 85 HK] /9738

RECORD HUBEI OUTPUT--Wuhan, 9 Dec (XINHUA)--By 6 December, Hubei Province had prefulfilled its annual power generating plan 33 days ahead of schedule, having generated 20.06 billion kWh electricity, an all-time high. [Summary] [Beijing XINHUA Domestic Service in Chinese 0825 GMT 9 Dec 85 OW] /9738

HUBEI POWER PRODUCTION--The power industry developed rapidly in the province during the Sixth Five-Year Plan. The province has fulfilled the targets set in the Sixth Five-Year Plan for power industry production 5 months ahead of schedule. During the Sixth Five-Year Plan, the average annual increase rate of the province's generated electricity was 10.09 percent. The accumulated length of the rural high-tension network in the province increased by about 100 percent over 1980. About 86 percent of townships and over 76 percent of villages in the province now have electricity. [Summary] [Wuhan Hubei Provincial Service in Mandarin 1100 GMT 29 Nov 85 HK] /7358

LIAONING 500 KV LINE OPERATIONAL--The first Chinese-built 500kV ultra high-tension power transmission line has been built in our province and was formally put into operation on 27 November. The operation of this line will enable the power grid to increase its power transmission capacity for the southern part of the province by more than 1 million kW. This ultra high-tension transmission line starts from Jinzhou, and runs through Yixian, Beizhen, Pan-shan, and Taian counties to Liaoyang. The total length of the line is 159 km. After 1 year's test operation, all equipment for this line has tested out, is functioning normally, and has met design standards. [Text] [Shenyang Liaoning Provincial Service in Mandarin 1030 GMT 27 Nov 85 SK] /7358

TONGLING 220KV TRANSFORMER--In the afternoon of 26 September, the Tongling transformer station was completed and became operational. The first 220 KV transformer station in the western Jiangnan region of Anhui Province, it will boost the supply of electricity to the Tongling and Chizhou areas and to a portion of Anqing Prefecture. For quite some time now, power supply in western Jiangnan has relied on the Tongling 37,000 kW generator and a 50,000 kW reserve generator and electricity was transmitted via a single 20-year-old 110kV power line. [Excerpt] [Hefei ANHUI RIBAO in Chinese 11 Oct 85 p 3] /6662

500 KV LINE PROTECTOR DEVELOPED--Zhengzhou, December 14 (XINHUA)--China has developed a protective device for 500kV transmission lines. The device, developed in the Xuchang relay factory in Henan Province, has passed technical appraisals by a state board, local officials said today. It has proved to be reliable through trial use on the Liaoyang-Jinzhou transmission line in Liaoning Province since 1984. [Text] [Beijing XINHUA in English 1527 GMT 14 Dec 85 OW] /8918

CSO: 4010/24

HYDROPOWER

STATE PLANNING COMMISSION APPROVES LIJIAXIA FEASIBILITY STUDY

HK241445 Xining Qinghai Provincial Service in Mandarin 2330 GMT 20 Dec 85

[Text] With the consent of the State Council, the State Planning Commission recently approved the report of the Ministry of Water Resources and Electric Power asking for instructions on the construction of Lijiaxia Hydropower Station in Qinghai.

Lijiaxia is situated about 100 kilometers from the Longyangxia station. The river here is narrow and flows rapidly, which is suitable for the construction of a large hydropower station. After several years' survey, a design department put forward a feasibility study report for the construction of Lijiaxia Hydropower Station and held that the conditions for development are good and economic results marked.

In its approval, the State Planning Commission agreed to the proposal for an installed capacity of 1.6 million kilowatts during the flood season and on the reservation for the expansion of a generator unit. Throughout the whole project, the form of inviting tenders and concluding contracts will be adopted. At present, the Northwest Survey and Design Institute of the Ministry of Water Resources and Electric Power is making technological preparations prior to the start of construction.

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CSO: 4013/47

3 February 1986

HYDROPOWER

GEZHOUBA KEY WATER CONSERVANCY PROJECT DETAILED

Beijing TUMU GONGCHENG XUEBAO [CHINA CIVIL ENGINEERING JOURNAL] in Chinese
Vol 18 No 3, Aug 85 pp 90-95

[Article by the Gezhouba Water Conservancy Project Bureau: "The Chang Jiang Gezhouba Key Water Conservancy Project"]

[Text] The Gezhouba key water conservancy project (Figure 1) is the first large dam to be built in the upper reaches of the Chang Jiang, and it is a component part of the Chang Jiang Sanxia [Three Gorges] key water conservancy project. After the Sanxia key water conservancy project is completed, it will assume the tasks of tail water regulation at the Sanxia reservoir and improvement of the navigation channel between the Sanxia dam site and Nanjinguan.

The common efforts of design, scientific research, manufacturing, and construction personnel at the Gezhouba project have led to the completion of the first project phase and the flow of the Dajiang ["large river"--see below] was cut off victoriously on 4 January 1981.

The accumulated water was opened for navigation in June and formal power generation at the first generator of the Erjiang ["second river"--see below] power station began in July. The second period of project construction began in 1982 and work on this stage is now proceeding urgently. The plan is for the first group of generators at the Dajiang power station to begin generating electricity in 1986. The project will be completed in 1988.

I. Natural Conditions at the Key Project

The Gezhouba project is located in the northern part of Yichang City in Hubei Province. The outlet of the three gorges lies at Nanjinguan about 3 km downstream and it is 37 km from the Sanxia dam site. After flowing out of the gorges, the Chang Jiang turns eastward and then abruptly southward. The width of the river's surface expands suddenly from 300 m at Nanjinguan to 2,200 m at the dam site, and the water depth drops from 80 m to 15 m. A high and precipitous counterslope forms in the river bed and the current bursts through a mountain pass on the left bank. The effects of rock ridges and other things cause the main current to move toward the right bank. The major changes in the terrain in this section of the river lead to the formation of very complex current conditions. At the dam site of the Gezhouba project, the Gezhou Dam

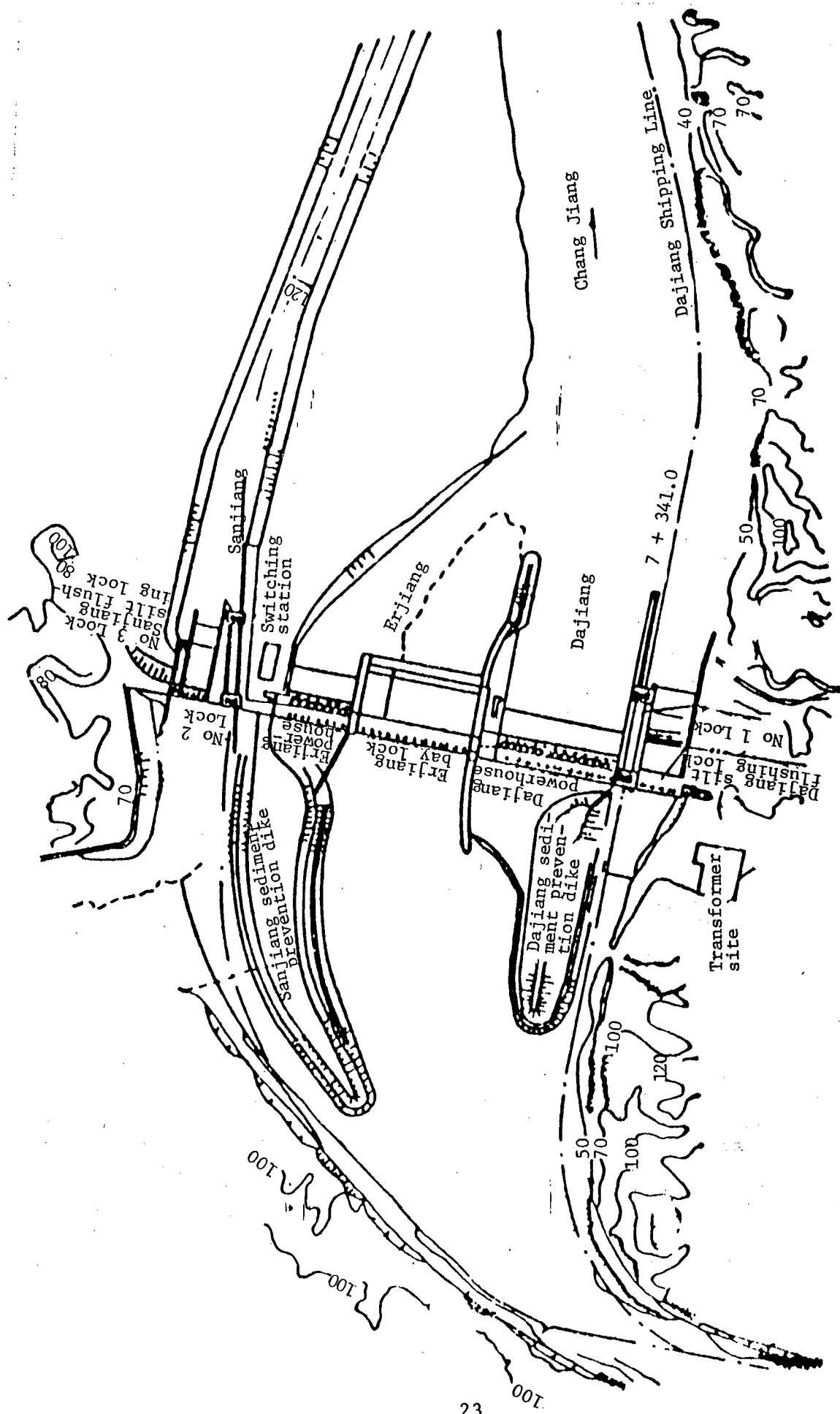


Figure 1.

is located in the middle of the river and there are two islands at the western dam, which divides the Chang Jiang into the Dajiang [large river], Erjiang [second river] and Sanjiang [third river], as shown in Figure 1. The Dajiang on the right side is the main river channel and the second and third rivers stop flowing during the dry season. The terrain is conducive to a two-period construction project.

The dam site will control 1 million km² of the area from which the Chang Jiang collects its water, equal to 55 percent of the area of the river basin as a whole. According to records of hydrological observations covering a 102-year period at the Yichang Hydrology Station as well as a large amount of survey material on historical floods, the dam site has an average annual flow rate of 14,300 m³/sec and long-term average annual runoff of 453 billion m³. The maximum flow during past floods covered in historical surveys occurred in 1870 and was 110,000 m³/sec. The maximum observed floodwaters were 71,100 m³/sec in 1896, 66,800 m³/sec in 1954, and most recently 72,000 m³/sec in 1981. Dry season flow rates generally appear during February, the minimum being 2,700 m³/sec.

According to silt measurements taken at the Yichang Hydrology Station over the past 30 years, the average yearly amount of silt is 520 million tons. This is composed of 450 million tons of silt less than 0.1 mm in diameter, about 61 million tons of riverbed silt material 0.1 to 1 mm in diameter and about 570,000 tons of coarse sand, gravel, and oolitic rock larger than 1 mm. This latter figure includes 420,000 tons of oolitic rock larger than 10 mm.

The strata at the dam site are Cretaceous conglomerate, powdery sandstone, clayey powdery sandstone, sandstone, and so on. There are soft interbeds of clay and the rock strata assume a laminar distribution inclined toward the west bank and slightly downstream at a slope of 4 to 8 degrees. The clay rock weathers rather quickly and has a poor washout resistance. The slightly inclined soft interbeds have a small friction coefficient. The friction coefficient of the muddy strata at the Erjiang power station is less than 0.20. The gentle angle of inclination and the muddy interbeds became the controlling factors for the stability of the large dam. There are strongly previous zones formed by faults with gentle angles of inclination at the foundation of the Sanjiang No 2 lock and the Dajiang power station and No 1 lock. These are major engineering geology problems that have appeared during foundation processing.

II. The Project Design Situation

1. Layout of the key project

The primary physical structures in the Gezhouba project include ship locks, flood drainage locks, silt flushing locks, flow cutoff facilities, and others. The layout of the key project was determined by experienced research and modeling over several years. The design principles are: 1) There should be no accumulation that would obstruct traffic in shipping channels, the vertical and horizontal flow rates must not be greater than specific values, and

flotillas must be able to enter the locks and shipping channels easily; 2) the flood drainage facilities must be capable of handling a maximum floodwater flow amount of $110,000 \text{ m}^3/\text{sec}$, and there should be safe flow diversion and smooth flow cutoff during the construction period; 3) the power plant must be able to take in water easily and the amount of silt passing through the generators should be kept as low as possible. The results of the experiments indicate that the key project utilizes the characteristics of the force of the river above and below the dam through installation of two navigation channels on the left and right sides of the river bed in combination with three locks and two upstream silt prevention dikes. These separate the two shipping channels from the trunk. To excavate the Genzouba site, 27 flood drainage locks were installed in the middle of the river bed. There are two powerhouses between the shipping channels and the flood drainage locks.

The layout of the key project moving from the left to the right bank is shown in Figure 1: an earthen dam on the left bank, the No 3 lock, the 6 silt flushing locks in the Sanjiang, a nonspillway dam, the No 2 lock, the concrete core wall dam at the Huangcao Dam, the Erjiang powerhouse, the plant lock guide wall, the 27 flood drainage locks of the Erjiang and the concrete vertical batardeau (the above were laid out during the first project period), the Dajiang powerhouse, the No 1 lock, the 9 silt flushing locks of the Dajiang, and the concrete dam on the right bank (the above are to be built during the second project period).

2. The primary physical structures

1) Navigational facilities

The navigational facilities include locks and shipping channels. The locks are single level ones with a maximum head of 27 m. The lock chambers of the No 1 and 2 locks have an effective length of 280 m and a net width of 34 m, and the minimum water depth at the thresholds is 5 m. A 12,000- to 16,000-ton flotilla can pass through each time. Each passage takes about 51 to 57 minutes and the time required to fill or empty the locks is 8 to 12 minutes. The lock chamber of the No 3 lock has an effective length of 120 m and a net width of 18 m. The minimum water depth at the threshold is 3.5 m. It can handle 3,000-ton or smaller passenger and cargo vessels and local flotillas. About 40 minutes is required for each passage and the time required to fill or empty it is about 5 to 8 minutes. The main upper and lower lock gates use a miter sill. These miter sills of the lower gates of locks 1 and 2 are 9.7 m across, 34 m tall, and 2.7 m thick, weighing about 600 tons. The miter sills use mechanical-drive gear-shaft connecting rods and there are inspection and repair gates on the upstream and downstream sides of the locks. To resolve the contradiction between ship passage and opening the dam top to traffic, railway, and highway bridges were a net lifting height of 18 m are constructed in the pier section of the No 2 and 3 locks and a highway bridge has been built below the lock at the Dajiang boat lock.

On the Sanjiang, the downstream incoming ship channel at the Sanjiang extends for a total of 6.4 km and the upstream incoming ship channel extends for 2.5 km. It is a minimum of 200 m wide and is 250 m wide at the outlet. The lower

shipping channel extends for 3.9 m and has a minimum bottom width of 120 m and a bottom width of 150 m at the outlet. On the Dajiang, the upstream incoming ship channel extends for 2.4 km, while the downstream shipping channel extends for 1 km and has a bottom width of 250 m. The downstream channel extends for 1.4 km and has a bottom width of 160 m. The dual floating arm type Sanjiang highway bridge has been completed over the Sanjiang shipping channel 2 km downstream from the large dam. It can handle 50 ton trucks and is a communications link between Yichang City and the area west of the dam as well as a construction task for the second project period. The Sanjiang highway bridge has a net width of 15 m and is more than 760 m long. The intermediate arch is 150 m and the net navigational width is 100 m.

2) Hydroelectric power stations

There are two hydroelectric powerhouses on the Erjiang and Dajiang. The Erjiang powerhouse will house two 170,000 kw and five 125,000 kw hydraulic turbine generators with a total installed capacity of 965,000 kw. The Dajiang powerhouse will contain fourteen 125,000 kw hydraulic turbine generators and have an installed generator capacity of 1.75 million kw. The total installed generator capacity at the power stations will be 2.715 million kw. Both of the power station plant buildings will have silt guide channels and silt drainage base holes to prevent silt accumulation in front of the buildings and also to reduce losses to water turbine generators caused by coarse sand passing through the generators. Two 220 kV and 500 kV switching stations will be built at the power station at the western dam and the right bank, respectively, to send power to the outside.

3) Flood drainage facilities

a) Erjiang will have a total of 27 flood drainage locks. The width of flow cutoff at the forward position is 498 m and the maximum drainage rate is 83,900 m³/sec. They are in the main flood drainage facilities at the Gezhouba key project. In view of a comprehensive consideration of the requirements in flood drainage, flow cutoff, silt discharge and other areas, an open flat-bottomed lock style was adopted. The lock chamber extends for 65 m and the base plate of the lock has an elevation of 37 m. The holes are 12 m wide and 24 m high. Upper and lower locks are installed at each hole, the upper one being a flat plate lock and the other an arched lock, both of them 12 by 12 m. To adapt to bedrock deformation and strengthen the integrity of the structure, a pattern linking three holes together was adopted, the two outside piers being 4.5 m thick and the two middle piers being 5.3 m thick. A shape-holding structure of prestressed steel wire bundles were installed within the lock piers to deal with the 4,200 tons of force from the water borne by each of the arched gates, each bundle bearing 300 tons of force.

The maximum single-width flow rate of the apron is 170 m³/sec. Many model experiments were done because of the weakness of the bedrock and a one-level flat-bottomed force dissipating pool 180 m long was decided upon in the end. A 70 m long anti-washout protection reinforced section is connected behind the pool. The anti-washout facilities at the tail of the lock include a 20-meter-deep retaining wall and an 85-meter-long concrete stilling pool

The total length of the apron is 335 m. The apron of the force dissipation pool is a regionally closed water drawing and drainage structure with a layer of washout-resistant durable concrete 40 cm thick. The pressure resistance is 400 kg/cm^2 . To facilitate adjustment and operation, there are 6, 12, and 9 holes in the left, middle, and right areas, respectively, as well as dividing walls between them. Each area can be operated or inspected and repaired individually.

A cable hoist is used to open and close the arched gates, while the flat plates are opened and closed with two 250 ton dam-top gate machines.

b) There are six silt flushing locks at Sanjiang with a total width of 108 m and a maximum drainage capacity of $10,500 \text{ m}^3/\text{sec}$. They are used mainly to divert the flow and pull out the sand. They provide guarantees for shipping in the Sanjiang ship channel and the No 2 and 3 locks, and they also participate in floodwater drainage during the rainy season. A flat-bottomed lock was chosen as the form for the locks and the lock chambers are 58 m long. The bottom plates of the locks have an elevation of 43 m and the lock holes have a net width of 12 m. Arched lock gates measuring 12 by 10.5 m will be installed and opened and closed by cable hoists. Each of the piers on either side of the lock holes are 3 m thick and are an integral structure. The supporting arm is borne on top of the cross beam and there are prestressed steel wire bundles, each bundle bearing 300 tons of force, anchoring them within the lock piers. A three-stage force dissipation pool with a total length of 405 m long is used below the locks.

c) The Dajiang has nine silt flushing locks with a total width of 166.8 m and a maximum flow rate of $20,000 \text{ m}^3/\text{sec}$. They are used mainly to divert the flow and draw off silt, and they provide guarantees for shipping in the Dajiang ship channel and the No 1 lock, and they also participate in floodwater drainage during the rainy season. Flat-bottomed locks are used and the lock chambers are 57.3 m long. The lock bottoms are at an elevation of 41.5 m and the net width of the lock holes is 12 m. There are arched lock gates measuring 12 by 19.5 m and the arched gates are supported by prestressed steel wire shapeholding structures. There is a washout-resistant spread cover upstream and a two-level force dissipation pool downstream. The total length of the smooth current flow including the lock chambers is 490.3 m.

III. Project Construction

The terrain at the dam site caused the project to adopt a scheduled flow diversion period method to divide the whole project into two construction periods. During the first period, the base pits of the Erjiang and Sanjiang were formed using a batardeau and the entire flow passed through the Dajiang. During the second period, the Dajiang was cut off and the facilities built on the Erjiang and Sanjiang easily drained the water. The batardeau was constructed during the second period and the Dajiang project was undertaken. The actual amount of engineering completed for the main facilities of the project during the first phase at the Gezhouba key project were 6.26 million m^3 of concrete, excavation of 51.35 million m^3 of earth, and installation of 37,600 tons of metal structures. The planned total amount of work for the second

period of the project is 4.87 million m³ of concrete, excavation of 23.90 million m³ of earth and installation of 39,900 tons of metal structures.

1. Project characteristics

1) A large scope of construction. The axial line of the dam during the second project period is more than 2,595 m long and it has an upstream and downstream range of about 7 km.

2) Complex structures. Most of the main facilities are piers, beams and thin-walled tunnel structures. Construction procedures are complex and there was a large proportion of unusual templates and reinforcement bars. The cross-flow section of the facilities account for more than 40 percent of the total length of the dam axis line. The technical requirements are high, there are large metal structures of many types and precision requirements are high.

3) A high degree of engineering. Peak annual extraction of earth was nearly 10 million m³ or more. More than 5 million tons of filling were done each year and concrete pouring has exceeded 2 million tons per year. Installation of machinery for opening and closing the lock gates and other metal structures peaked at 19,000 tons per year. Moreover, there also was a great deal of basic processing, grouting of seams in the dam body and so on.

4) Poor natural conditions. The basement is weak, there are large amounts of floodwaters that carry a great deal of silt, the climatic conditions are poor and there are great temperature differentials. This placed rather high technical requirements on structure building. When excavating the soft interbeds, for example, the flood drainage locks mainly were excavated using a multitoothed trough, some reaching more than 30 m in depth. The greatest excavation depth during the plant building and primary generator stages exceeded 40 m. Resistance to washout and durability were required of the concrete, and there were strict temperature requirements during the pouring and grouting periods. Anchor pilings and chemical grouting were used for processing the foundation.

2. Construction methods employed for the main facilities

1) Excavation projects

A sunken hole drill rig was used to bore holes for blasting. Precracked blasting techniques were employed to assure that the design corridor line was not destroyed during excavation at the outside slopes of the bedrock. The outcome of practice has been that prefractured blasting provides very good results in the soft strata encountered in this project. The excavation machinery mainly was electrically-powered excavators with a 4 m³ bucket capacity, and 20 to 32 ton dump trucks were used to haul out the debris. Many different measures were employed to meet a variety of conditions during underwater excavation. Cutter suction dredges with work capacities of 1,720 m³/hour and 350 m³/hour were used to excavate the fine layers of sand that had accumulated in the river bed. A continuous bucket sand dredge with a working capacity of 250 m³/hour was used to excavate normal sand and oolitic rock. The underwater cemented sandy conglomerate and bedrock were extracted using a flat platform blasting boat and

a submarine rock dredge with a bucket capacity of 4 m^3 in conjunction with a 120 m^3 capacity bottom-running boat to move out the debris.

2) Foundation processing

a) Heavy curtain grouting. The total length of heavy curtain grouting during the first and second project periods was 53,000 m. It was done mainly using cement grout and a small amount of chemical grout. Water drainage holes were installed downstream from the holes in the heavy curtain and inverse filtering measures were employed within the holes.

b) Foundation consolidation grouting. Consolidation grouting was employed almost universally on important structures. Cement was used mainly, with consideration given to chemical grouting at important locations according to the conditions of the foundation. The pressure of the grouting on the laminar foundation made it easy for the surface to lift up and expand. This made it necessary to permit grouting with concrete more than 4 m thick on the foundation.

c) Foundation anchoring. Foundation anchoring measures were employed downstream from the flood drainage locks and plant buildings on the thin weak strata of the foundation. A blast drill was used to bore holes (with a diameter of 850 mm) and a geological drilling rock was used to bore holes (219 mm in diameter) for the anchoring measures. The holes generally were 10 to 15 m deep and a reinforcing bar skeleton was inserted after which concrete was poured to create anchor pilings. Anchor piling reinforcement was used for the batardeau of the Dajiang silt flushing locks. The bore holes were 168 mm in diameter and the holes were 4 to 7 m deep.

3) Concrete projects

a) Sand and rock aggregate production: Natural sand and oolitic rock aggregate was used entirely. Continuous bucket sand dredges with capacities of 250 and $750 \text{ m}^3/\text{hour}$ were used in combination with a 180 m^3 sand transporter. A special dock was built and a belt conveyor behind the right upper bank was used to transfer it to the raw material heaps. Sand and rock sifting production capacity reached $1,300 \text{ m}^3/\text{hour}$ during the first period and $720 \text{ m}^3/\text{hour}$ during the second period. After sifting, it was divided into five types of aggregate: sand, 5-20 mm, 20-40 mm, 40-80 mm, and 80 to 120 mm.

b) Cement: Two types of cement were used based on design requirements. One type was No 525 pure large dam cement, which was used on the spillway and important structural locations. It was mixed for 28 days into a concrete with a strength of more than 300 kg/cm^2 . Concrete was used on regular locations and the foundation and the cement was hauled in loose form by rail to the work site. It is stored in a cement tank near the mixing system and can meet peak demand for pouring structures of more than 7 days.

c) Concrete mixing plants: Mixing systems were built on the left and right banks and at the west dam based on the distribution of structures. There were a total of eight mixing buildings during the first period with a total mixing capacity of $355,000 \text{ m}^3/\text{month}$. There were six mixing buildings during the

second period with a total mixing capacity of 320,000 m³/month. The mixed concrete mainly was shipped by locomotive with some going by truck.

d) Concrete temperature reducing measures: The atmospheric temperature in the Yichang region is rather high during the summer, so measures to reduce temperature had to be adopted to guarantee normal construction with the concrete. The temperature reducing measures now used in this project mainly were to precool the aggregate, mix in ice and other comprehensive measures. Cold air at -5°C is used to blow it into the aggregate storehouse in the mixing buildings and the 20-40 mm and 40-80 mm aggregates are precooled. Ice is added, generally 50 to 60 kg of cracked ice per m of concrete. This permitted the temperature of the concrete at the outlet of the mixers in the mixing building to be lowered from the summer temperature of about 32° to 38°C to one of 14° to 17°C. The refrigeration capacity is 7.5 million kilocalories/hour. During the second period, a 2°C cold water spray bath is used and after dehydration it is moved into the aggregate storehouse at the mixing plant where -14°C cold air is used to air-cool the 20-40, 40-80, and 80-120 mm aggregate, after which it is mixed with ice. This lowered the temperature at the outlet of the mixer to around 7°C. The refrigeration capacity is 16.87 million kilocalories/hour.

e) Concrete pouring. The project bureau set up a comprehensive processing plant to be responsible for the processing or reinforcing bars, formworks and other prefabricated structures which then are shipped to the pouring sites. The formworks used during the first period were mainly wood molds, while the second period mainly uses steel molds as well as prefabricated concrete molds, floating arm forms and hydraulically lifted flat steel formworks. The pouring of the concrete is handled mainly by a 10 to 25 foot crane outfitted with a 3 m³ concrete hanging tank to move it into storage. To meet the needs of pouring the power station plant buildings, a large crane was specially designed and manufactured. Its lifting arm has a maximum length of 62 m and it can be used in combination with a 6 m³ hanging tank. The maximum suspended weight when the arm is 26 m long is 60 tons and a manually operated inserted vibrator with a vibration frequency of 8,000 to 10,000 times per minute is used to shake the concrete.

IV. Flow Cutoff and the Batardeau Project on the Dajiang

Many design and construction units cooperated to do a great deal of scientific experiments and preparation work to assure the success of the flow cutoff projects, and they convened several nationwide technical examination and investigation conferences to derive the optimum program for flow cutoff.

1. Flow cutoff programs and measures

Programs for an upstream single-support cubical plug, a stacked bridge flat plug, a floating bridge plug and upstream and downstream dual-support cubical plugs and other programs were studied for cutoff of the Dajiang. A single-support cubical plug program was adopted in the end. Based on a design in which the head of the upstream single support cubical plug would not exceed 3 m and that the downstream support dike would bear a drop of 1 m in head,

preparations proceeded concurrently as a safety measure. The flow cutoff portal was 220 m wide and a 30 ton steel frame rock sieve and 17 ton concrete blocks were used to protect and roughen the bottom. The largest body in weight thrown in during the flow cutoff were tetrahedral concrete pieces weighing 25 tons.

The selection of the time period for cutting off the flow of the Dajiang gave all-round consideration to keeping the flow rate during cutoff rather small so as to decrease the difficulty of flow cutoff. There also was a need to allow sufficient filling time for the Dajiang batardeau to achieve safe flood-water passage at the batardeau. The time selected, therefore, was the last part of December and the first part of January. Based on hydrological statistical data, the monthly flow rates at a 5 percent frequency during December and January were $7,300 \text{ m}^3/\text{sec}$ and $520 \text{ m}^3/\text{sec}$. The flow rate during the actual cutoff was $4,720 \text{ m}^3/\text{sec}$. During the time the Dajiang is cut off, the river water passes through the upstream and downstream guide channels of the Erjiang and is drained off through the flood drainage locks. The upper guide channel on the Erjiang has a total length of 1,400 m and is 520 m wide. The middle of the channel bottom lies at an elevation of 37 m and is 40 m on either side.

The lower guide channel of the Erjiang is 1,300 m long and 570 m wide, and the elevation of the bottom of the channel is 37 m.

A total of 1.77 million m of stone was needed for the flow cutoff project, as were 3,290 tetrahedral concrete blocks weighing 10 and 25 tons. It was arranged in advance to leave an outlet 203 m wide for the cutoff and the maximum water depth was 10.7 m. Work began at 7:30 on 3 January 1981 when cubic plugs were put in place simultaneously on both banks. After 36 hours and 23 minutes, some $106,200 \text{ m}^3$ of fill had been thrown in, including 19 percent large stone, 41.9 percent medium sized stone and 33.83 percent ballast. The 15 ton tetrahedral concrete bodies accounted for 2.85 percent and the 25 ton tetrahedral concrete bodies for 2.98 percent. The actual amount of material thrown in daily on the left and right banks reached $72,000 \text{ m}^3$, which was the highest record for amount of material thrown in for flow cutoff in China.

2. The Dajiang batardeau

The upstream and downstream batardeaus at Dajiang were key projects to guarantee that it was opened to traffic and power generated during 1981 and for construction of the second period of the project. For this reason, construction of the upstream and downstream batardeaus at Dajiang began immediately after the flow cutoff outlet was closed. A total of more than 5 million m^3 of refill were used for the upstream and downstream batardeaus and two concrete leakage prevention walls were installed on the upstream batardeau. The Dajiang batardeau already has been tested by the floodwaters during the three rainy periods from 1981 to 1983, which proved that the quality of the construction was excellent.

3. The vertical apron

The vertical apron during the second period played a role in guiding the flow to block the water and preventing washout during the second period of the project at the Dajiang base pit. After the second period of the project is completed, a latticed steel plate piling batardeau will be installed as permanent structures along the lock chamber and the guide walls of the apron, which will be about 250 m long, and downstream. The upstream steel plate piling batardeau must be removed. The upstream and downstream latticed steel plate piling batardeaux will be joined into a long steel plate piling to form a 19.87 m diameter round body and additional joined arch section that will be installed on the curved concrete base and the hole will be filled with sand and rock to maintain stability.

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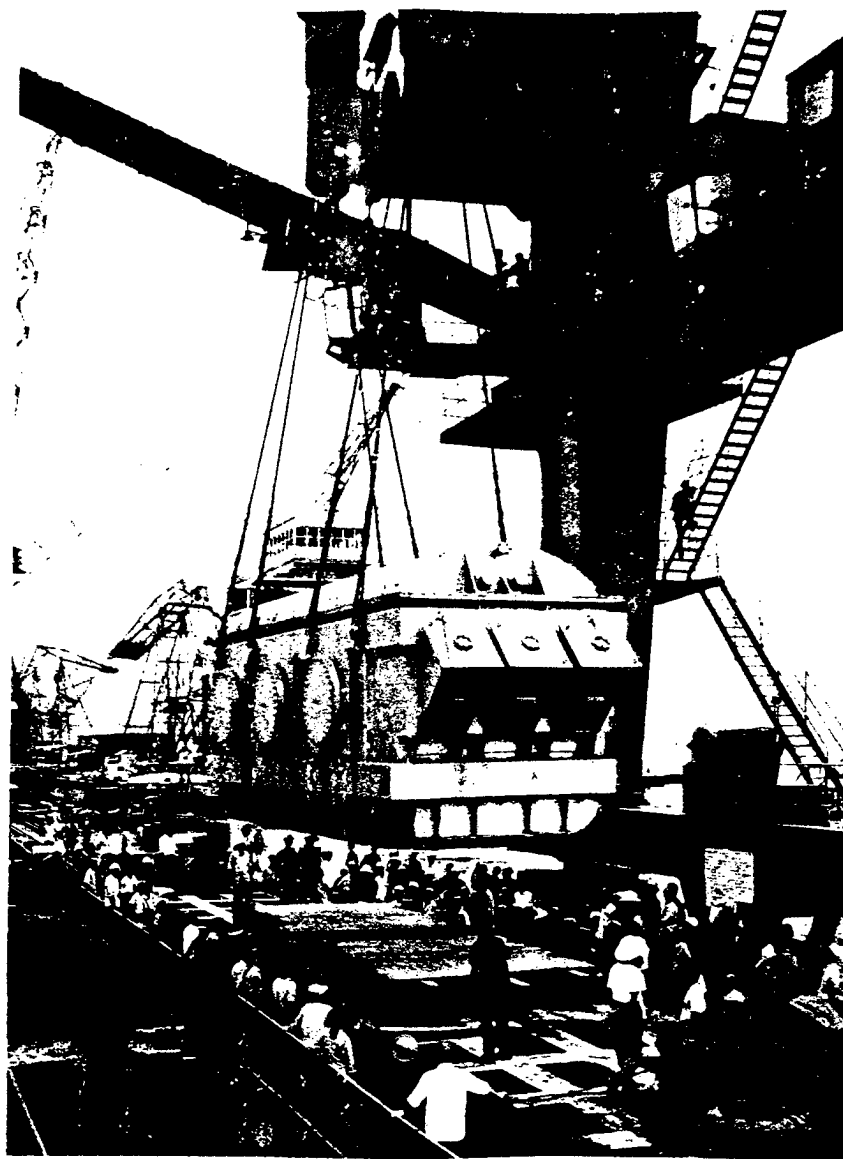
CSO: 4013/16

HYDROPOWER

BIG 360,000KVA TRANSFORMER SHIPPED TO GEZHOUBA

Beijing BEIJING REVIEW in English No 1, 6 Jan 86 inside front cover

[Photograph and caption]



This three-phase, 360,000 kVA transformer was recently shipped to Gezhouba, the site of China's largest hydroelectric power station. One of a pair destined for Gezhouba, the 8.8-meter-long, 3.9-meter-wide, and 4-meter-high transformer was built at the Shenyang Transformer Factory and is the largest to be designed and built by China itself.

CSO: 4013/

HYDROPOWER

FUJIAN LEADS THE WAY IN HYDROPOWER DEVELOPMENT

Small Projects Bring Electricity to Countryside

Fuzhou FUJIAN RIBAO in Chinese 2 Oct 85 p 1

[Article by Wu Jialin /0702 1367 2651/ of the Fujian Province Water Resources and Power Office: Total Small Hydropower Installed Generator Capacity in Fujian Surpasses 932,000 kW, Power Output Reaches 2.2 Billion kWh"]

[Text] Fujian Province's achievements in small hydropower construction in rural areas have been pleasing, and it now accounts for about 10 percent of total national installed generator capacity and annual power output, fourth in China. Yearly utilization time averaged 2,611 hours for Fujian as a whole, third place in China. According to statistics from Fujian hydropower departments for the middle part of September 1985, Fujian added a total of 260,000 kW in installed generator capacity during the Sixth Five-Year Plan, and the province has completed more than 8,770 small hydropower stations. Total installed generator capacity has surpassed 932,000 kW. Fujian now has 39 counties where installed capacity at small hydropower stations exceeds 10,000 kW, 11 of which have figures greater than 20,000 kW. The three counties and cities of Yong'an, Youxi, and Anxi have surpassed 30,000 kW.

The ten counties (and cities) of Yongchun, Yong'an, Youxi, Mingqing, Dehua, Jian'ou, Guangze, Nanjing, Liancheng, and Pingnan are among 100 rural electrification pilot counties in China that have accelerated their advance toward Chinese-style rural electrification standards. In Guangze County, per capita installed capacity has reached 150 kW and power output per capita has reached 333 kWh. The area of electricity use by peasant households has reached 97 percent. Indices in all items have reached centrally-proposed standards in 1985. Yong'an City has implemented the principle of the "three selves" and a policy of using electricity to develop electricity, and they have raised capital through many channels and levels. They constructed 21 power stations in only 2 years with newly added capacity of more than 8,700 kW. Total installed capacity in the city now exceeds 34,000 kW and it has leapt to first place in Fujian and second place in China. Annual power output exceeded 100 million kWh, first in China. Youxi County has used a dual focus on

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construction and management; progress in electrification there also has been fast. There is hope that the above city and county will achieve electrification before 1986. The area of electricity usage by peasant households in the above 10 counties and cities ranged from 81 to 99 percent. More than 160,000 wood-saving stoves and more than 80,000 electric skillets and various other appliances have been put into use.

The development of small hydropower construction has played a major role in promoting industrial and agricultural production in the cities, villages and mountainous regions of Fujian. Power output from small hydropower in Fujian now has surpassed 2.2 billion kWh, and it provides sufficient electrical power for industrial and agricultural production and for the people's lives in every country.

Larger Projects Help Stabilize Grid

Fuzhou FUJIAN RIBAO in Chinese 30 Sep 85 p 2

/Article: "Fujian's Developing Hydropower Resources"

/Text/ Fujian has enormous hydropower resources and is the champion among the provinces in eastern China. Fujian has theoretical hydropower resource reserves of 10.16 million kW, including 7.05 million kW that could be developed with an installed generator capacity of more than 500 kW, for a yearly output of 32 billion kWh.

Fujian now has developed 1.05 million kW in total hydropower resource capacity, which is only 14.9 percent of the developable total capacity. Only 760,000 kW in capacity have been developed in the Min Jiang river basin, equal to 17.4 percent of the developable capacity in the Min Jiang river basin. The Ting Jiang river basin has developed only 7.5 percent, the Jiulong Jiang river basin has developed only 7.5 percent, the Jiulong Jiang river basin has developed only 27.3 percent and the Zhu He in eastern Fujian has developed 39.7 percent. It is obvious that the current degree of hydropower resource utilization is very low and awaits our efforts to develop it.

Electric power is an important energy resource. To achieve a quadrupling of the total value of industrial and agricultural output by the end of this century, there must be a 7.4 percent average annual increase in the total value of industrial and agricultural output. The average yearly rate of increase in electricity usage, however, is 8.36 percent. For this reason, Fujian plans to build and put into operation hydropower stations at Shaxikou, Fancuo, Gongchuan, and Shaxian during the Seventh Five-Year Plan. Cascade hydropower stations at Shuikou, Mianhuatan, Jinxi, and Shaxi also may continue to be constructed and go into operation from the later part of the Seventh Five-Year Plan to the 1990's. In addition, the Zhouning hydropower station in eastern Fujian also may be built. Moreover, to satisfy electric power equilibrium in power networks, besides accelerated

construction of the Zhangping thermal power plant to burn Longyan and Yongdian anthracite, the Fuzhou thermal power plant that will burn bituminous coal shipped into Fujian by sea from other provinces also will be completed and go into operation. In this way, it is possible that power networks with double the power output and a rather rational proportion of hydropower and thermal power will appear during the latter part of the Seventh Five-Year Plan. We can see here that if we achieve the above power development principle and plans for construction and operation of power stations, we will be able to keep pace with the rate of growth in power use and with rate of development of the total value of industrial and agricultural output, and we may even be slightly ahead.

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CSO: 4013/26

HYDROPOWER

SMALL STATIONS ARE BACKBONE OF XINJIANG RURAL ELECTRIFICATION

Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 21 Nov 85 p 3

[Article: "Xinjiang's Small Hydropower Develops Vigorously; 45 Percent of Peasant Households Use Electricity"]

[Text] Since the Xinjiang Uygur Autonomous Region was established 30 years ago, the construction of small hydropower stations in the countryside has developed vigorously. Currently, each county in the autonomous region has a hydropower station, 80 percent of all counties rely mainly on hydropower stations for power, and 45 percent of all peasants use electricity.

The Autonomous Region People's Government is paying close attention to the use of each area's resources for developing small hydropower. According to statistics, Xinjiang has already built small hydropower plants with an installed capacity of 228,600 kW, and they will be able to generate 508 million kWh of electricity annually: this is more than a 3,300-fold increase compared to the period before liberation. Xinjiang has 26,400 km of high-voltage power transmission lines, 19,400 km of low-voltage transmission lines, 147 35-kV transformer substations with an installed capacity of 451,200 kVA, and more than 16,000 distribution transformers and an installed capacity of 996,300 kVA.

Xinjiang covers a vast expanse of territory, and the fertile regions are separated by desert or by high mountains. If we develop power using the method of supplying electricity through a large power network, it will be expensive, difficult, and uneconomical. Because small hydropower is developed on-the-spot, the scale is small, the period of construction is short, costs are low, results are achieved quickly and this arouses the enthusiasm of the masses for managing their power. The small hydropower stations that have been built have provided neighboring villages with the electricity for lighting, for processing rural produce and sideline products and for rural and township enterprises, and this has brought some measures of convenience to the lives of the people. Qiqia'er with an elevation of more than 3,000 meters in the past relied on long-distance rail transport for its coal, but recently built a small hydropower station, and the residents of this place used electricity to boil water, cook food, for lighting and heating, and this changed the living conditions of these people.

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HYDROPOWER

BRIEFS

NATIONAL SMALL HYDROPOWER STATISTICS--Beijing, 25 Dec (XINHUA)--One-third of the electricity used in China's farming comes from small hydropower stations, according to the Ministry of Water Resources and Electric Power today. Such stations, mostly built by peasants themselves, will produce 22.6 billion kWh in 1985, 1.78 billion kWh more than in 1984. The ministry classifies a station with a generating capacity of 25,000 kW as small. [Text]
[Beijing XINHUA in English 1144 GMT 25 Dec 85 OW] /9738

JILIN DOUBLES SMALL HYDRO CAPACITY--Changchun, 28 Dec (XINHUA)--The installed capacity of small hydropower stations in Jilin Province has almost doubled since 1980. A local official noted here today that the capacity has increased from 70,400 kW in 1980 to the present 131,000 kW in this major industrial base. The hydropower stations each with a capacity of less than 25,000 kW, produce electricity largely for industrial, agricultural, and household use in their local counties. In some cases, they also provide electricity for major enterprises in the province. The target set for the development of Jilin's hydropower stations during the Sixth Five-Year Plan (1981 to 1985) has already been surpassed, the official said. [Summary] [Beijing XINHUA in English 0645 GMT 28 Dec 85 OW] /9738

HONGSHI 500 MW UNIT--On the afternoon of 13 December, the first 500MW generating unit of the Hongshi Hydropower Plant in Jilin Province began to store water. It will soon be put into test operation. [Text]
[Changchun Jilin Provincial Service in Mandarin 2200 GMT 13 Dec 85 SK] /9738

ANHUI SMALL HYDROPOWER--From 1983 to the end of this year, more than 300 small hydropower stations were built in Anhui Province, and some 7,000 kilometers of high- and low-tension power lines installed. The total installed capacity of these small hydropower stations was 90,000 kilowatts, a 44-percent increase over 1980. In the past 5 years, these power stations generated a total of 560 million kWh of electricity. [Summary]
[Hefei Anhui Provincial Service in Mandarin 1100 GMT 12 Dec 85 OW] /9738

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LUBUGE UPDATE--On the 13th, the flow of water was blocked at the Lubuge hydroelectric power station on the Huangni He in Guizhou Province, one of state's major construction projects for the Sixth Five-Year Plan. The Lubuge hydropower station is the largest of the six cascade power stations in the cascade development of the Huangni He. Total investment will be 690 million yuan, including a World Bank loan of 84 million dollars U.S. Lubuge is the first construction project to be undertaken by the nation's hydropower industry using foreign funds and technology. The station is scheduled for completion in 1989. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 17 Nov 85 p 1] /6662

HUANG HE HYDROPOWER DEVELOPMENT--By the end of September, China had built four hydropower stations on the upper reaches of the Huang He with a total generating capacity of more than 120 billion kWh. Since the founding of the People's Republic, the state has considered the upper reaches of the Huang He (the Huang He Delta east of Hekou in Nei Monggol's Togtoh County) as a key spot for the development of hydropower resources. Since 1958, the state has invested more than 1.19 billion yuan to build Yanguaxia, Qingtongxia, Liuguoxia and Bapanxia hydropower stations on this stretch of the Huang He. These four hydropower stations have a total of 26 water turbogenerators with a total installed capacity of 2 million kW, and each year can generate more than 9 billion kWh. In 1961, one after the other they began to generate electricity. [Text] [Beijing RENMIN RIBAO in Chinese 29 Sep 85 p 1] /12232

CSO: 4013/29

THERMAL POWER

YUNNAN'S LARGEST FACILITY NOW ON STREAM

OW182027 Beijing XINHUA in English 1635 GMT 18 Dec 85

[Text] Kunming, 18 Dec (XINHUA)--The Xiaolongtan thermal power plant, the largest in Yunnan Province, went into operation today in Kaiyuan County.

The 600,000 kilowatt generating unit will increase the generating capacity of the province by more than 55 percent, up from the 1.06 million kilowatts in 1980.

According to Li Degang, director of the provincial power industry bureau, another power facility, the Lubuge hydroelectric power station on a tributary of the Nanpan Jiang, will go into operation in 4 years with a capacity of 600,000 kilowatts.

These two projects will ensure that by 1990, the province will have doubled its generating capacity from 1980.

Other thermal and hydroelectric power facilities are under construction, including a hydroelectric station with a capacity of 1.5 million kilowatts on the middle reaches of the Lancang Jiang.

The province's 600 rivers are suitable for installing generating units with a total capacity of 71.16 million kilowatts but Yunnan's generating capacity at present accounts for only 1.7 percent of its total, Director Li said.

"We will strive to build Yunnan into one of China's energy bases with a total generating capacity of up to 5.43 million kilowatts by the end of this century," he added.

Almost all the counties in the province have erected small power stations.

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THERMAL POWER

FUJIAN'S ZHANGPING POWER PLANT BEING RUSHED TO COMPLETION

Fuzhou FUJIAN RIBAO in Chinese 14 Nov 85 p 1

[Text] Construction work on the Zhangping thermal power plant, a major project in Fujian Province, is progressing rapidly. According to statistics, at the end of October [1985], 93 percent of the work had been completed. The provincial 1st Construction Company completed the 180-meter-high stack on 31 October in only 62 days, 19 days ahead of the original plan. The plant buildings have already taken shape and more than half of the plant's entrance road has been surfaced.

After the Zhangping thermal power plant has been completed, it will have a generating capacity of 200,000 kilowatts and the electricity will be supplied chiefly to the Xiamen Special Economic Zone and the Minnan region. It is a joint investment crash energy resource project being undertaken by Fujian and the central authorities.

Special Railroad Spur for Power Plant Completed

An associated project of the Zhangping thermal power plant, a special railroad spur, was opened for traffic at the end of October, the construction being completed 15 days ahead of the original plan.

This special spur was built by the Zhangping No 2 Construction Section of the Fujian Railway Construction Company. Since construction began on 8 January 1985, with much overtime and extra shifts, some 214,000 cubic meters of earth and rock were moved, 11 culverts were completed, a 24-meter prestressed concrete bridge was built, and two sets of switches were installed. The track itself is 2.374 kilometers in length.

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CSO: 4013/49

THERMAL POWER

YUANBAOSHAN 600MW UNIT NOW OPERATIONAL

Hohhot NEIMENGGU RIBAO in Chinese 15 Nov 85 p 1

[Summary] China's largest single-unit gas turbine generator, a 600,000 kW unit at the Yuanbaoshan power plant, became operational on 13 November [1985]. As part of the second-phase construction project of the Yuanbaoshan facility, the unit was built with the assistance of foreign technicians.

The unit is one of the major construction projects under the Sixth Five-Year Plan, and all of the equipment was imported from France and the Federal Republic of Germany. The unit is the most automated of any unit in a Chinese thermal power plant and the entire operation, from boiler ignition to the feeding of electricity into the grid, is controlled by electronic computers. Computers also monitor the unit's operations, report accidents, and handle breakdowns. Television cameras monitor the furnace. Compared to the already installed units, its coal consumption is 20 grams less per kilowatt-hour of electricity generated, a savings of some 70,000 tons of raw coal a year.

Begun in May 1981, the project was the responsibility of the First Construction Company of the Northeast Power Management Bureau.

The unit should generate 3.6 billion kilowatt-hours of electricity a year which will be fed into the grid via a 500kV ultrahigh tension power line and play a major role in easing the power shortage in the northeast.

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THERMAL POWER

BRIEFS

NEW URUMQI GENERATOR--The No. 8 generator of the Hongyanchi power plant a key project in the Sixth Five-Year Plan in Xinjiang, was completed on 21 December. The regional electric power bureau held a celebration this afternoon in which regional CPC Committee Secretary Song Hanliang cut the ribbon. Regional Advisory Commission Chairman Wang Enmao was present. Regional Government Chairman Tomur Dawamat made a speech. The capacity of the new generator set is 50,000 kilowatts. It can generate 25 million kilowatt-hours of power in the first year of operation, representing one-eighth of the total power generation in the Urumqi area at present. [Excerpt] [Urumqi Xinjiang Regional Service in Mandarin 1300 GMT 24 Dec 85 HK] /9738

QINLING ADDS 200MW UNIT--Xian, 24 Dec (XINHUA)--A 200 MW generator went into operation today at the massive Qinling Thermal Power Plant in Huayin County, Shaanxi Province. Its construction was part of the State Council's plan to add 5 million kW of generating capacity in 1985. It is part of a major expansion scheme at the Qinling plant, which has already had a capacity of 850,000 kW. Another generator of the same capacity will be installed next year. [Text] [Beijing XINHUA in English 1838 GMT 24 Dec 85 OW] /9738

ZOUXIAN 300MW UNIT JOINS GRID--On 2 December, the first 300MW generating unit of the Zouxian County Power Plant, a key state project joined the power grid after being successfully switched on. On 4 December, Li Peng, vice-premier of the State Council, sent a congratulatory message to the headquarters of the worksite of the Zouxian County Power Plant. The congratulatory message states: I am very glad to learn that the Zouxian County Power Plant has achieved success in the 72-hour full-load test of its first 300MW generating unit. By accomplishing the task rapidly and with high quality you have set an example in the campaign to build generating units with a total installed capacity of 5 million kW this year. [Summary] [Jinan Shandong Provincial Service in Mandarin 2300 GMT 14 Dec 85 SK] /9738

YAOMENG UPDATE--Zhengzhou, 24 Dec (XINHUA)--An electricity generating unit with a designed capacity of 300MW went into operation on Sunday at the Yaomeng Thermal Power Plant in Henan Province. This marked completion of the second phase of an expansion scheme at the plant, a key project in the nation's Sixth Five-Year Plan (1981-1985). The generating unit, on which

work began in 1983, will help ease the electricity shortage in central China, local officials said. The Yaomeng Power Plant is near the Pingdingshan Coal Mine, China's third largest. It now has a total generating capacity of 900MW. [Text] [Beijing XINHUA in English 0756 GMT 24 Dec 85 OW] /9738

SECOND TONGLIAO UNIT OPERATIONAL--Following the first 200 MW generating unit which went into operation on 13 August this year, the second 200MW generating unit of the Tongliao power plant in Nei Monggol Autonomous Region went into operation on 17 December. The total installed capacity of the Tongliao power plant is 280,000 kW. [Summary] [Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 18 Dec 85 SK] /9738

HENAN 1000MW PLANT--Zhengzhou, 7 Dec (XINHUA)--The construction of a large thermal power plant is under way in Yanshi County in the western part of the province. The Shouyangshan plant, jointly built by the Central Government and the Henan Provincial Government, will have an installed capacity of 1 million kW. The first phase of construction, involving two generating units each with a generating capacity of 200,000 kW, will be completed in early 1987; construction of the second phase is to start during the Seventh Five-Year Plan (1986-1990). [Text] [Beijing XINHUA in English 1634 GMT 7 Dec 85 OW] /6662

DAWUKOU UPDATE--Yinchuan, 5 Dec (XINHUA)--With the opening of a 100,000-kW generating unit in a new thermal power plant recently, Ningxia Hui Autonomous Region is now more than self-sufficient in electricity. The Dawukou plant will eventually have a generating capacity of 400,000 kW, and produce 2 billion kWh upon completion in 1987, according to local officials. Ningxia's installed capacity is now over 600,000 kW, capable of supplying neighboring provinces, the officials said. The region, under the self-government of the Islamic huis, plans to build another thermal power plant in the next 5-year period. Ningxia is rich in coal and hydropower and will focus on the development of power industry to promote growth of other industries. [Text] [Beijing XINHUA in English 0912 GMT 5 Dec 85 OW] /6662

ZHANGZE FIRST STAGE COMPLETED--Taiyuan, 27 Nov (XINHUA)--The first stage of a massive power plant, the Zhangze power plant, in southern Shanxi, China's leading coal-producing province, went into operation on Sunday. The first unit has a generating capacity of 100,000 kilowatts and was completed 6 months ahead of schedule, said local officials. The whole coal-fired plant, scheduled for completion during the country's Seventh Five-Year Plan (1986-1990), will have a capacity of 1 million kilowatts. The first stage will power a chemical fertilizer plant, which is being fitted out with equipment from Federal Germany and Japan, and an electric railway from Taiyuan to Jiaozuo. The Zhangze plant is the third major power plant to be built by the government in Shanxi. [Text] [Beijing XINHUA in English 1619 GMT 27 Nov 85 OW] /7358

XUZHOU UPDATE--Nanjing, 19 Nov (XINHUA)--The Xuzhou Power Plant's first 200,000-kilowatt generator was put into operation on 5 November. A total of four 200,000-kilowatt generator sets will be installed for the third-phase project of the Xuzhou Power Plant, which is a key state construction project. With the added generator, the power plant's total installed generating capacity has reached 700,000 kilowatts. [Summary] [Beijing XINHUA Domestic Service in Chinese 0006 GMT 19 Nov 85 OW] /7358

ZHEJIANG POWER INDUSTRY GROWTH--Hangzhou, 17 Nov (XINHUA)--The electric power industry has developed rapidly in Zhejiang during the Sixth Five-Year Plan Period. Newly installed generating capacity exceeded 1.08 million kilowatts, approximately 40 percent of the installed generating capacity at the end of 1980. Total thermal power generating capacity installed in the last 5 years exceeded the total capacity installed in the preceding 30 years. During the past 5 years, the province has generated 53.9 billion kilowatt-hours of electricity, 91 percent more than in the preceding 5 years. It is estimated that by the end of this year the total installed generating capacity of the province will reach 3.8 million kilowatts, which will be able to generate 12.2 billion kilowatt-hours of electricity annually, about 206 times greater than that at the early period of liberation. [Summary] [Beijing XINHUA Domestic Service in Chinese 0057 GMT 17 Nov 85 OW] /7358

NEI MONGGOL 600MW UNIT--A 600,000-kilowatt turbogenerator went into operation at the Yuanbaoshan power plant on 13 November. The construction and installation of this generator was a key state project during the Sixth Five-Year Plan period. The equipment for this generator was imported from foreign countries, and its operation is managed by computers. After being placed into production this generator will generate 3.6 billion kWh of electricity annually. It will play an important part in easing the power shortage in the northeast region and promoting industrial, agricultural, and animal husbandry production. /Summary/ /Hohhot Nei Monggol Regional Service in Mandarin 1100 GMT 16 Nov 85 SK/ 12228

CONSTRUCTION BEGINS ON FUZHOU PLANT--Fuzhou, 9 Dec (ZHONGGUO XINWEN SHE)--The first phase of the project to build the largest harbor power plant in Fujian Province, the Fuzhou thermal power plant, which will have a total generating capacity of 1.4 million kilowatts, began today. The Fuzhou thermal power plant is a project being carried out by a Chinese-foreign joint venture, which was set up by the Huaneng International Electricity Development Company and the Fujian provincial authorities. The project involves a total investment of 1.1 billion yuan, which includes foreign investment of 220 million. The power plant will generate 3.5 billion kilowatt-hours of electricity each year. This is equal to half the present electricity output in Fujian. The project is considered one of the key construction projects in Fujian Province for the next 5 years. The power plant is located in Chouqi Village, Changle County, near the mouth of the Min Jiang. In the first phase of the project, two sets of imported generators with a total generating capacity of 350,000 kilowatts will be installed, a 20,000-ton coal dock will be built, and a 220,000-Watt transmission network will be put into operation. [Text] [Beijing ZHONGGUO XINWEN SHE in Chinese 1400 GMT 9 Dec 85 HK] /6662

LUOHE 300MW UNIT OPERATIONAL--Hefei, 18 Dec (XINHUA)--The first generating unit with a capacity of 300,000 kW went into operation Monday at a thermopower plant in a coal field south of the Huai He in Anhui Province. Electricity from the generator has already been conducted to the power grid in east China where the economy is developed but electricity supply is lacking. Some of the booster machines of the generator were imported. The Luohe plant will eventually have four generators of the same capacity. In the vicinity of the coal field another big thermopower plant, Pingwei, is being installed and an existing one is being renovated. It was estimated that by 1989, the total generating capacity in the Huainan area will reach 2.4 million kW, which will greatly please the power shortage in east China. [Text] [Beijing XINHUA in English 0719 GMT 18 Dec 85 OW] /8918

DALIAN 700MW PLANT--Dalian, 11 Dec (XINHUA)--Dalian in northeast China [will build] a new power plant before 1990. The power plant, with a generating capacity of 700MW, is near a new coal terminal, local officials said. When completed at a cost of 1.1 billion yuan, the plant will be able to generate 4.2 billion kWh of electricity a year. [Text] [Beijing XINHUA in English 1537 GMT 11 Dec 85 OW] /8918

XINGTAI EXPANSION--A power generating unit with a capacity of 200MW went into operation in Hebei Province on Friday. It is part of the Xingtai Electric Power Plant now under expansion, which will eventually have a generating capacity of 890MW. Work on the project began in 1983. [Text] [Beijing CHINA DAILY in English 16 Dec 85 p 3] /8918

300MW UNIT FOR SHANDONG--Shanghai, 29 Dec (XINHUA)--The manufacturing of a 300MW generating unit was completed here today. The unit, including a generator, a steam turbine, and other facilities, will be installed in a thermal power plant in Shandong Province. The manufacturing technology was transferred by two U.S. firms. China began producing 300MW units in 1970. Eleven units have been manufactured and seven have gone on stream. In manufacturing this unit, Shanghai plants developed new processes while absorbing the imported technology. The success has provided experience for manufacturing similar generating units in the Seventh Five-Year Plan period. [Summary] [Beijing XINHUA in English 1434 GMT 29 Dec 85 OW] /8918

PINGWEI STATUS REPORT--Construction of the Pingwei coal-fired power plant -- east China's biggest, with a total generating capacity of 2.4 million kilowatts -- is progressing toward a 1987 opening date, according to a local official in Hefei. The plant in Huainan City, Anhui Province, is designed to power four 600,000-kilowatt generators and alleviate power shortages in east China. While the first generator is expected to open in 1987, the project is scheduled to be completed about 1990. [Text] [Beijing CHINA DAILY in English 8 Jan 86 p 3]

CSO: 4010/29

COAL

'85 OUTPUT PLACES NATION IN SECOND PLACE WORLDWIDE

Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 1 Dec 85 p 1

[Text] Beijing, 30 Nov, XINHUA--This reporter has learned from the Ministry of Coal Industry that the estimated coal production for China in 1985 could reach 830 million tons to put China in second place in the world.

The information provided by the Ministry of Coal Industry shows that during the period of the Sixth Five-Year Plan, China's coal industry experienced an unprecedentedly good situation. As coal production increased year after year, capital construction was accelerated and enterprise economy improved so that the Sixth Five-Year Plan was completed 2 years ahead of schedule.

The Ministry of Coal Industry's favorable situation is a result of implementing the central government's coal industry policies of "making use of available resources" and "state-run, collective and individual joining together, and large, medium and small-sized mines working together," and is also a result of striving to implement reforms. The Ministry of Coal Industry, through investigation and experience, is promoting contracted production for centralized procurement mines, and is implementing a wage contract per ton of coal and an economic responsibility system for guaranteeing capital construction. At the same time, it is relaxing policies and developing local mines, especially rural and township mines.

These reforms have created changes favorable for developing the coal industry.

/6662

CSO: 4013/40

COAL

COAL MINISTRY OFFICIAL SAYS 1986 TARGET IS 870 MILLION TONS

OW040836 Beijing XINHUA in English 0718 GMT 4 Dec 85

[Text] Beijing, 4 Dec (XINHUA)--China is to produce 870 million tons of coal next year, a national conference on coal production was told here today.

China's coal output is expected to reach 830 million tons this year, 40 million more than planned, Vice-minister Ye Qing said.

The vice-minister said that the industry should increase its efforts next year so as to cut more coal for the national economy in the Seventh Five-Year Plan (1986-1990).

In 1986, 47 percent of coal cutting in the country's major mines is to be semi-mechanized, and another 24.2 percent fully mechanized, he said.

This means an increase of 2.3 percent and 2 percent respectively over the 1985 figures.

He urged the industry to improve management, strengthen quality control and build a number of model mines with advanced technology in the coming year.

Mechanization and technology of coal mines should be upgraded, Ye Qing said.

/6662

CSO: 4010/20

COAL

LOCAL MINES NOW ACCOUNT FOR MORE THAN HALF OF TOTAL OUTPUT

OW161150 Beijing XINHUA in English 1125 GMT 16 Dec 85

[Text] Beijing, 16 Dec (XINHUA)--China's coal production this year is expected to hit 830 million tons, of which 420 million, or more than half of the total, will be produced by local mines.

Local coal mines include mines run by provinces, prefectures and counties, collectively run mines, mines funded by local people and coal pits owned by individuals.

The ongoing reform of China's economic structure, which first started in the rural areas in 1979, has greatly spurred the development of local mines, especially those run by townships.

Since 1983, the state has adopted a series of flexible policies toward local mines, including those on coal reserves, mine management, transportation, marketing and price.

As a result, large, medium-sized and small coal mines run by the state, collectives, and individuals have been developed spontaneously.

The development of local mines has greatly reduced the strains on China's major coal mines and helped to ration the geographic distribution of energy, meet the needs of local industrial and agricultural production and enliven local markets.

During the Sixth Five-Year Plan (1981-1985), the state and local governments allocated 4.460 billion yuan for the construction and technological transformation of mines run by provinces, prefectures, or counties.

According to statistics provided by 21 provinces, autonomous regions and municipalities, funds of various kinds totalling 1.82 billion yuan have been spent in the past 5 years on township coal mines. The profits from the coal have been reinvested in the mines to increase output.

Despite their progress, local coal mines still face many problems such as lack of capital, lack of a large enough area for the peasants to mine, lack of advanced equipment, difficulty in transportation, and above-average number of pit accidents.

A national conference on coal production held early this month decided that the Ministry of Coal Industry is to give further support to local coal mines in reserves, technology, equipment and funds during the Seventh Five-Year Plan (1986-1990). It will also help local mines enhance management and safety and broaden transportation and marketing channels.

Officials of the ministry said that they are confident that local coal mines will achieve an average annual increase of 20 million tons in the next 5 years and their coal output will reach 500 million tons by 1990.

/8918

CSO: 4010/24

COAL

DEPOSITS OF 110 BILLION TONS FOUND DURING SIXTH FIVE-YEAR PLAN

OW020724 Beijing XINHUA in English 0707 GMT 2 Jan 86

[Text] Beijing, 2 Jan (XINHUA)--The Ministry of Coal Industry discovered 110 billion tons of deposits during the Sixth Five-Year Plan which ended last year, a ministry official said here today.

This was 2.3 times the target set in the plan, said the official.

And the ministry expects to verify another 50 billion tons in the major coal-producing areas of Shanxi, Henan, Anhui, Shandong, and Heilongjiang provinces during the Seventh Five-Year Plan which has just begun.

Coal output last year is estimated at 830 million tons--40 million more than planned--and is expected to reach 1 billion tons by 1990.

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CSO: 4010/24

COAL

MINE PRODUCTION IN SIXTH FIVE-YEAR PLAN RECAPPED

OW031638 Beijing XINHUA in English 1521 GMT 3 Dec 85

[Text] Beijing, 3 Dec (XINHUA)--China has developed 224 new mines during the Sixth Five-Year Plan (1981-1985), XINHUA learned from a national conference on coal production here today.

These mines have a combined annual production capacity of 79.8 million tons, 34 percent more than those built in the preceding 5 years.

Mines with an aggregate annual production capacity of 153 million tons are also under construction.

From 1981 through 1985, the country invested 56 percent more than in the Fifth Five-Year Plan period (1976-1980) on mines and relevant projects. The total investment in the past 5 years came to 22 billion yuan.

Coal is the primary source of energy in China and now constitutes about 70 percent of the country's energy.

The expansion of the coal industry was coupled with a speed-up in mine construction.

The average time needed for developing a coal mine has been shortened to 77 months from 101 months in 1980, and a number of medium-sized and small mines have been built within 2 or 3 years, thanks to the institution of a contract responsibility system.

The construction period of large mines, each capable of producing 3 million tons a year, has also been reduced to about 6 years from 8 or 9 years.

In China, a coal mine with a designed annual production capacity under 450,000 tons is called a small mine, and those with capacity ranging from 450,000 to 900,000 tons are listed as medium-sized ones. Those above 900,000 tons are termed large mines.

During the Sixth Five-Year Plan, geologists working in the industry discovered 110 billion tons of coal reserves, more than twice as much as expected.

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CSO: 4010/20

COAL

AS SHORTAGE EASES, MORE COAL WILL BE EXPORTED

HK041003 Beijing ZHONGGUO XINWEN SHE in Chinese 1330 GMT 2 Dec 85

[Report: "Li Peng Says Coal Shortage in China Has Been Eased"]

[Text] Beijing, 12 Dec (CZHONGGUO XINWEN SHE)--This afternoon, at a national conference of representatives of model workers and advanced units on the coal industry front, Vice Premier Li Peng said that the coal shortage in China has been eased, and that in the future coal will become one of China's important export commodities.

Vice Premier Li Peng pointed out that in coal production, it is not only necessary to attach importance to output but also to the development of good quality and more varieties. It is necessary to produce more coking coal, anthracite, and fine-quality coal for power production to meet the needs of the international market.

It was said that China's current coal exports have not reached even 1 percent of total output, and the total export this year is estimated at 7 million tons.

Li Peng said that by implementing the policies of "extracting coal as quickly as possible" and "developing large, medium-sized, and small coal mines simultaneously," the Chinese Government has achieved very good results over the past year in coal production. Particularly, various local mines, large or small, have played an important role in the development of the coal industry. However, the vice-premier stressed that it is now necessary to shift the attention of local mines to technical transformation, safe production, and rational use and protection of natural resources.

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CSO: 4013/37

COAL

SHANXI TARGET IS 400 MILLION TONS/YEAR BY 2000

OW301522 Beijing XINHUA in English 1429 GMT 30 Dec 85

[Text] Taiyuan, 30 Dec (XINHUA)--Shanxi Province, China's leading coal producer, is producing more than 200 million tons this year, accounting for one-fourth of the nation's annual output.

Most of the key mines run by the government now use equipment imported from Federal Germany, the United States, Britain, Poland, and Japan, provincial officials said today.

The nation's coal output is planned to reach 870 million tons in 1986, and the annual coal target for Shanxi by the end of this century is 400 million tons.

The province also encourages the development of small mines by rural collectives. These mines are producing 90 million tons this year, three times the 1980 output.

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CSO: 4010/24

COAL

IMPORTED EQUIPMENT BOOSTS SHANXI MINE OUTPUT

OW121150 Beijing XINHUA in English 1132 GMT 12 Dec 85

[Text] Taiyuan, 12 Dec (XINHUA)--The import of advanced technology and equipment has boosted coal production and reduced manpower in Shanxi, China's leading coal producer, over the past 5 years.

Two-thirds of the province's extra 19 million tons of coal during this period was due to adoption of advanced technology and equipment, said Wu Sansong, director of the Provincial Coal Industrial Bureau.

In seven major coal mines, the number of miners needed for an additional output of 10,000 tons of coal has been cut down from 21.5 persons to 3.6 over the past 5 years.

Shanxi began to upgrade its mines in the late 1970s. Now one out of every three teams in the province is equipped with mechanical cutters imported from the Federal Republic of Germany, the United States, Britain, Poland, or Japan.

The Luan Coal Administration, the first in the country equipped with advanced machinery, cut 87 percent of its coal by machine in the first 11 months.

Technical advances have forced miners to study general knowledge and sharpen their working skills. Over 60 percent of miners in Shanxi have attained a middle school educational level, compared with about 20 percent in 1980.

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CSO: 4010/21

OUTSTANDING CHARACTERISTICS OF SHANXI COAL LISTED

Beijing BANYUE TAN [SEMI-MONTHLY TALKS] in Chinese No 20, Oct 85 pp 38-39

[Article by the Shanxi Branch of Xinhua and the Shanxi Province Statistics Bureau: "A Coal Town Worthy of Its Name--Shanxi in the National Context"]

[Excerpt] 1. First place nationwide in coal reserves. Shanxi has 204.8 billion tons in proven coal reserves, about one-third of China's proven reserves.

2. A full complement of coal varieties. It has gas coal, rich coal, primary coking coal, lean coal, anthracite, poor coal, weak cohesive coal, long-flame coal and other primary coal varieties.

3. The greatest number of coal mines. There were a total of 62 unified distribution coal mines at the end of 1984 with a production capacity of 70.78 million tons; 180 prefecture and county-run coal mines with a production capacity of 24.74 million tons; and 3,189 township and small town coal mines with an annual capacity of 70.65 million tons.

4. The highest coal output. Shanxi produced 187.16 million tons of raw coal in 1984, equal to 24.2 percent of total coal output in China and first place among all of the provinces, municipalities and autonomous regions in China.

5. The greatest amount of coal shipped out. Shanxi shipped out 124.81 million tons in 1984, including out-shipments of 90.35 million tons of unified distribution coal or 68.1 percent of net out-shipments of unified distribution coal in China.

6. The greatest amount of coal exported. Shanxi directly exported 3.07 million tons of coal in 1984, equal to 44.2 percent of China's direct coal exports.

7. Highest output of anthracite block coal. Anthracite block coal output reached 5.83 million tons in 1984, equal to 67.4 percent of total anthracite block coal output in China.

8. The Bishui coal field covers an area of 29,500 square kilometers and remains the largest coal field in China to this day.

9. The Datong mining district is the largest coal producing region in China at present, and it also is China's largest power coal base area. Annual raw coal output reached 29 million tons in 1984.
10. The lowest coal costs in China. The cost per ton of raw coal in unified distribution mines in Shanxi was 18.14 yuan in 1984, which was 5.44 yuan per ton lower than the cost per ton of raw coal for all of China's unified distribution mines.
11. It has turned over the most profits in the coal industry. Profits actually turned over by independent accounting coal enterprises under ownership by the whole people were 2.323 billion yuan, which was the highest in the coal industry of all of China's provinces, municipalities and autonomous regions.
12. The highest full personnel efficiency of unified distribution mines. The full personnel efficiency of unified distribution coal mines in 1984 was 1.461 tons/worker, which is 0.558 tons/worker higher than that national level.
13. The Pingshuo open-pit mine is the first coal enterprise to be developed jointly by China and the United States. It also is one of the five largest open-pit mines under key development by the state and has a total scale of 50 million tons.

12539/12955
CSO: 4013/24

COAL

JILIN-BASED COAL FIRM FULFILLS STATE PLAN EARLY

OW061817 Beijing XINHUA in English 1628 GMT 6 Dec 85

[Text] Changchun, 6 Dec (XINHUA)--China's only multi-regional coal industry corporation, based in Changchun, Jilin Province, turned out 95.68 million tons of coal in the first 11 months of this year, fulfilling the state plan 1 month ahead of schedule.

That accounted for more than one-tenth of the country's total coal output for 1985.

The coal output this year for the northeast China and Inner Mongolia joint coal industry corporation, established 10 January 1983, is expected to surpass 100 million tons, 5 million tons over the state plan, officials from the corporation said.

Since 1983 the corporation's output has increased by an average of 6 percent, or 7 million tons annually. This has greatly eased the energy supply shortage in the northeast region, China's main heavy industrial base.

The corporation has renovated some of its old mines with advanced technology and equipment to retain their production capacity, officials said.

New technology has also been employed to shorten the construction period for new mines.

The Yiminhe and Huolin open-cut mines, two of the corporation's three major ones in the Inner Mongolia Autonomous Region, have already gone into partial operation, officials said.

Directly under the coal industry ministry, the joint coal corporation runs all the major coal mines in Liaoning, Jilin, and Heilongjiang provinces, and Inner Mongolia, which have total coal reserves of 64 billion tons.

The establishment of the joint corporation has made it easy to plan the development and use of the local reserves, the officials said.

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CSO: 4010/24

COAL

HEILONGJIANG'S LOCAL MINES EXPAND DRESSING CAPACITY

Harbin HEILONGJIANG RIBAO in Chinese 2 Oct 85 p 1

[Article: "Matching Development of Local Coal Mine Construction--Excellent Conditions Created for Sustained Growth in Coal"]

[Text] Local coal mines in Heilongjiang have adhered to the principle of combining production with construction. While developing production they also have developed matching capital construction and created excellent conditions for sustained increased in production.

Local coal mines built a total of 42 new shaft mines between 1982 and the present time, and these newly added shafts have a total production capacity of 4.4 million tons. Thirty of these newly built mines have gone into production and have an annual capacity of 2.25 million tons. The remaining 12 mines will go into production in succession during the early part of the Seventh Five-Year Plan. To guarantee that local coal mines continue to undergo substantial growth during the Seventh Five-Year Plan period, the state has decided to invest in local coal mines in Heilongjiang to build a group of key local coal mines with a total design capacity of 8 million tons. Heilongjiang is to become one of China's ten key coal production base areas.

While involved in building new shafts, local coal mines in Heilongjiang also have striven to build coal dressing plants. After 3 years' effort, the Jidong coal mine collected capital on its own to build a dressing plant capable of dressing 450,000 tons of raw coal a year. It went into operation in 1984 and increased the number of coal varieties and improved the quality of the coal. This mine increased its income by 1.13 million yuan in 1984 just by dressing the coal, and it has received more than 900,000 yuan in increased income through the first 8 months of 1985. In 1985, local coal mines also built two new medium-sized coal dressing plants with a capacity of 450,000 tons. The Shengping Mine coal dressing plant went into operation in September. Another site is the Beigang coal washing plant, for which all types of preparatory work for construction now are underway. When completed, these two plants can solve the pure powdered coal problems of the Heilongjiang Chemical plant and the Xilin Iron and Steel Mill, and it can make 5 million yuan a year in profits.

To provide sufficient coal for a key state project--the Yilan coal gas project--the Yilan open-pit coal mine opened formally in June 1985.

Heilongjiang has several geological prospecting teams engaged in exploratory drilling in many places. They have provided 25 geological reports for mine construction and more than 500 million tons in exploitable reserves.

A bidding system now is quite widespread in capital construction within Heilongjiang's local coal mine system. Bidding is done in design, construction, expenses and other areas to select and use the best, improve project quality and lower construction costs. Moreover, they have implemented contractual responsibility for expenditures during construction and accelerated the pace of construction. The No 6 shaft at the Xianchang Mine, for example, has a design capacity of 150,000 tons. After contractual responsibility for construction was implemented, a 3-year work schedule was completed in 1 and one-half years and it went into operation ahead of schedule.

12539/12955
CSO: 443/24

COAL

SICHUAN MINES REPORT MORE EFFICIENT COAL DRESSING

Chengdu SICHUAN RIBAO in Chinese 28 Sep 85 p 1

[Article: "An Excellent Use for Gas and Coal Gangue--Coal Mines at the Provincial Level and Above in Sichuan Make Active Use of Resources in Mining Districts To Develop Comprehensive Utilization"]

[Text] Coal mines at the provincial level and above in Sichuan have made active use of mining district resources and carried out washing and dressing to develop comprehensive utilization, with an obvious increase in economic results.

Whether done to develop comprehensive utilization or to improve the grade and value of the coal, the development of washing and dressing is important. Coal mines at the provincial level and above in Sichuan focused on this work in 1984 and washed a total of 6.4 million tons of raw coal. The Yongrong Mining District washed 1.48 million tons of raw coal and made over 12 million yuan in profits. In addition, washing and processing reduced the ash content of the commodity coal and greatly reduced the amount of ash and gangue that was shipped out. This saved shipping capacity and alleviated the transportation shortage.

The mines have adopted several measures to deal with the gangue that is produced in extracting and washing. All of the coal mines at the provincial level and above in Sichuan have used gangue to build gangue brick plants. The annual production capacity now has reached 100 million bricks and they can process 300,000 tons of gangue yearly. Bricks produced with gangue are acid resistant, alkaline resistant and very strong and have become an excellent construction material for use in capital construction. This also has reduced the land area taken up by the dumping of gangue. All of the coal mines have turned a disadvantage into an advantage and transformed waste into wealth. Key coal mines in Sichuan discharged 68.2 million cubic meters of underground methane gas in 1984 making use of more than 3 million cubic meters of it. The Tianfu Mining Bureau uses gas to produce carbon black and had 250,000 yuan in profits in 1984. Some mines also have provided the gas to families on a widespread basis for heating water, cooking, and heating, which has conserved coal and improved the living conditions of employees. Moreover, some key coal mines in Sichuan have build pit-mouth power plants that utilize low thermal value coal to generate electricity, and they have processed a large amount of gangue that has saved a great deal of transport capacity and increased supplies of electricity.

COAL

ANHUI 1.8 MILLION-TON MINE NOW OPERATIONAL

OW282005 Beijing XINHUA in English 1948 GMT 28 Dec 85

[Text] Hefei, 28 Dec (XINHUA)--A coal mine which can produce 1,800,000 tons a year went into operation today in northern Anhui Province.

The Linhuan colliery south of Huaibei will double the yearly output of the mines built in the coal field between 1981 and 1985 to 3,600,000 tons, and is expected to ease the shortage of coal in eastern China.

The pit is rich in quality coal, and is thought to have a life of more than 120 years. It will supply fuel for the massive Baoshan iron and steel complex in Shanghai.

Another seven local collieries and coal dressing plants are under construction, and will go into operation over the next 5 years.

/8918

CSO: 4010/24

COAL

NEW STRATEGIES FOR COAL EXPLOITATION

Taiyuan JISHU JINGJI YU GUANLI YANJIU /RESEARCH ON THE ECONOMICS OF MANAGEMENT AND TECHNOLOGY/ in Chinese No 4, Aug 85 pp 14-17

/Article by Zhang Qinwen /1728 3084 2429/: "New Strategies and New Viewpoints for Coal Development"/

/Text/ A new situation has appeared on China's coal front since the Third Plenum of the 11th CPC Central Committee. Rural and small town coal mines have grown rapidly at a rate of 17.5 million tons a year. Output in rural and small town coal mines topped the major barrier of 200 million tons in 1984, equal to 26 percent of China's raw coal output. In Shanxi, which is one of China's energy resource base areas and has several large state-run mines and local state-run mines, output from rural and small town coal mines in 1984 was 70.65 million tons, equal to 38.2 percent of raw coal output in the province. They have become one of the pillars of coal production, which is something new in China's socialist economic construction. From 26 to 30 January 1985, State Council Premier Comrade Zhao Ziyang went to Yanbei and Datong Prefectures for intensive survey research. He began with the actual conditions in Shanxi's energy resource base area and proposed strategic ideas for having the peasants mine the coal and the state handle communications. This is an energy development principle that fits our national conditions, conforms to the wishes of the people and has a particular Chinese character. It also is a strategic principle for making full use of the initiative of the state, localities and the peasants. It is an excellent policy that alleviates the state's financial problems while providing even greater economic benefits. It is a significant innovation in China's present economic development strategies at the present time, and it opens new routes for accelerated coal development in Shanxi and for meeting national energy demand.

I. The Inspiration for the New Strategy

Having the peasants mine the coal and the state handle communications is a major readjustment in the layout of coal production, transportation and marketing in the construction of the Shanxi energy resource base area, and is a structural change. First, having the state focus on communications and shipping construction will lead to substantial increases in Shanxi capacity for shipping out coal and make a fundamental change in the situation of coal output being reduced because of transport limitations.

This will accelerate coal development in Shanxi and lead to the gradual formation of a production, shipping and sales situation with benign cycles. Second, the state will focus on construction in communications and shipping and reduce its investments in coal development. This is not the same as weakening the links in coal production but relies on rural and small town coal mines and their ability to be born and grow themselves. This will shift the distribution of production from the former situation of dominance by state unified distribution mines and supplementation by local mines and rural and small town mines to a situation in which rural and small town mines are dominant and are supplemented by local mines and state-run unified distribution mines, thereby forming a highly vigorous ownership structure. This is to say that there will be major development of rural and small town coal mines, with the real significance being that: (1) The rate of growth in rural and small town coal mines in the future will be much greater than the rate of development in state-run unified distribution mines and local state-run mines. (2) Coal output from rural and small town coal mines will rise gradually to about one-half of total coal output in Shanxi.

The result of implementing this strategy will not be that coal output will decline but instead that it will grow even faster. The obvious improvement in Shanxi's coal out-shipment capacity will satisfy energy demand in industrial regions along the coast and accelerate the pace of economic growth in China. There can be an appropriate reduction in state investments, which will alleviate problems of insufficient capital for large scale construction. The fact that the peasants become wealthy by developing coal will be beneficial for readjustments in industrial structures in rural areas and it will accelerate the transition of rural areas from the self-sufficient and semi-self-sufficient economy to a commodity economy. It can be said that it kills several birds with one stone.

The new strategy has inspired us:

1. By placing communications and shipping in an even more important position than coal production, focusing on the most important of the important and the most urgent of the urgent, and changing from "restricting production because of shipping" to "focusing on shipping to promote production," implementation of this strategy is a dialectical method that of "playing the banjo in reverse." For a long time, a sort of simplified and direct perceptual handling of problems has appeared frequently in our guidance of economic construction. A simple mention of a focus on grain meant that emphasis was placed solely on grain. Grain became the key link and everything else was swept aside. The result was that a focus on grain never was achieved. For a period in the past, the state did not concentrate forces during construction of the Shanxi energy resource base area to create the conditions for shipping coal out of Shanxi and operated only on the basis of coal extraction. The result was that output was restricted by shipping capacity and serious waste was created by overstocks, self-combustion, weathering, wash-out and so on. Industrial regions along the coast, on the other hand, have had to shut off power supplies because of

energy shortages, which has restricted the development of production. Gansu has implemented a "playing the banjo in reverse," planted grass and trees, used livestock to promote agriculture and brought about a new situation in grain production. By "playing the banjo in reverse" in the Shanxi energy resource base area, focusing on shipping and using shipping to promote production, a new situation also certainly could appear in coal development.

2. By implementing this strategy, rural and small town coal mines would become the primary force in construction, thereby changing ownership structures in coal development. It can be predicted that an ownership structure that gives primacy to rural and small town coal mines will be even more vital and have more stamina than the state-run unified distribution mines that dominated in the past. A while ago, we had a stereotyped interpretation of "integration of the large, medium and small" and "the state, collectives and individuals advancing together" as meaning dominance by the large-scale and dominance by the state-run economy. This is a sort of rigid regulation, and it is indicative of a failure to understand objective reality and the developmental situation in socialist economic development. "Integration of the large, medium and small" and "the state, collectives and individuals advancing together" actually is a comprehensive structure in which different economic forms coexist. This sort of comprehensive structure can have different proportions and different forms of internal organization. These should be determined on the basis of actual conditions in the different realms of industry and in different regions and time periods. We should make use of the solid foundation formed by state-run unified distribution mines in Shanxi and focus on medium and small mines for a period into the future. This is especially true in the development of rural and small town mines, which can lead to a tendency toward rationality in the proportions of large, medium and small. Shanxi's coal resource conditions and socioeconomic conditions are conducive to the development of rural and small town mines. Moreover, reliance on the peasants to run mines could conserve on state investments, so the dominance of rural and small town mines in the future is suited to actualities in Shanxi and is a principle that adheres to "integration of the large, medium and small" in accordance with local conditions. Large numbers of instances of dominance by the collective economy, the cooperative economy or the individual economy can be found in certain other industrial spheres, regions and ownership structures. This does not affect the socialist direction in China's economic construction and we cannot use "leftist" teachings to restrict its development. The standard used to measure advance or retreat is whether the forces of production increase or decrease.

3. Implementation of the strategy of peasant coal extraction with the state managing communications would cause the formation of a socialized and open coal production and shipping system within which multiple layers and economically diverse forms coexist. This will make it possible for the state, localities, collectives and specialized households to work according to their ability and derive their own benefits. This is an

appropriate division of labor in economic construction and is a rational strategy for the financial resources of the people and the state. In the past, we stressed dominance by the state-run economy in all sectors. The reality was that the state bore the burden of everything and carried a millstone. Capital was scattered about everywhere, making it impossible to develop departments with centralized investments and instead weakening the leading role of the state-run economy. This can be seen in the fact that grain, coal, iron mining and other reclamation, cultivation and extraction industries in the rural areas where production sites are distributed had rather poor conditions in the area of the technologies they needed. Most of their products are raw materials whose processing and manufacture is held mostly in the hands of the state-run economy. It is entirely possible that they can be turned over to localities and the masses for management while making it possible for the state to concentrate its investments in high-technology departments in the secondary industries and emerging industries and in capital construction to create the material and environmental conditions for the joint needs of development in all industries. This would not weaken the leading role of the state-run economy but instead would give correct embodiment to the leading role of the state-run economy in a network of a rational distribution of labor among the state-run, collective and individual economies while making use of the local, collective and individual economies in an auxiliary role. Everyone is always discussing doing things according to abilities. Our understanding of this principle is that any industry or activity that can be handled by the masses should be handed over to the masses. Any industries and activities that localities can manage should be turned over to localities to run. The state should be involved only in industries and activities that the masses and localities cannot handle. This would allow state finances, local finances and the people's finances to make a contribution according to their ability.

4. By implementing this new strategy, the state could concentrate its investments on railway and key highway construction, which would stimulate localities and the peasants to invest in construction of secondary roads and manage small scale communications and shipping activities. Freer shipping and sales would provide a further stimulus for localities and the peasants to invest in even more coal development projects and run good coal collection, shipping and coal station construction, and it would promote comprehensive economic development of the commodity economy in rural areas while permitting state investments to play the leading role. In the past, we used state investments mainly in direct production projects. To use a metaphor, they were the result of addition. In the future, we must think of ways to use state capital as a "catalyst" that accelerates the "chemical combination" of the factors of production to form new forces of production. Thus, state investments do not have to be used only for direct production projects but instead should be used for construction projects that provide joint conditions that facilitate the development of thousands of enterprises and for projects that will lead localities and the masses to collect even more investments so that an investment of one yuan plays a role of several tens or hundreds of yuan to achieve the results of the multiplication and exponential methods.

II. Have a Correct View of New Problems

A new strategy for coal development requires readjustments in the planning and layout of coal production, communications and shipping as well as readjustment of policies related to coal development. This is another field of reform and requires that we change concepts and patterns that were formed over a long period in the past. It is inevitable that we will encounter resistance and problems and we should not fear them. We must be determined to make reforms and be strong and they will not be hard to resolve. We must, however, deal earnestly with some new problems.

1. Prevent superficial accounts. Although some administrative departments have done surveys, research and planning for rural and small town coal mines, their interest in large amounts of fixed assets for state-run unified distribution mines has not waned. They have not focused on real policy readjustments for supporting the development of rural and small town coal mines. We should take clear note that acceleration of energy resource development and out-shipment in Shanxi requires a resolute determination that the focus of key state investments will be shifted to communications and shipping construction for a great increase in Shanxi's capacity for shipping out coal. Large mines will not be involved in coal development in large numbers for a time to come. There will be no major increase in fixed assets, but they should be turned over for development by rural and small town coal mines. For several years in the past, we felt that development of rural and small town coal mines wasted much to gain little and restricted assistance to them, noting their many backward factors and few progressive factors. The implementation of the strategic principle of the peasants mining coal while the state handles communications first of all requires ideological shift of course and policy readjustments. It is necessary to examine and clarify all actual policies and decisions in the past that were related to the development of rural and small town coal mines. We must formulate policies that favor relaxation in the areas of resource allocations, approval to open mines, shipping services, raw coal exports and other macrolevel management problems to develop rural and small town mines quickly, and we should create the joint convenience situations and material bases for development of all rural and small town mines. This is something that must be done firmly.

2. We must prevent going against the current and holding back. Some comrades have said that strengthened leadership over rural and small town coal mines should focus on management and changes of existing management systems. For a long period, we have had a profound experience and lesson that deserves notice. It is that every time something new appears, we move to "strengthen leadership." There are two kinds of outcomes, one very good and one very bad. They are determined by whether or not we respect the developmental laws of the thing itself and use an opportunity to gain our intentions or whether we are detached from reality and objectively design some sort of "transformation and perfection" and other patterns that go against the current and hold back. If we consider their system of ownership, rural and small town coal mines are part of the rural and small town enterprise system, but if we consider their activities, they are part

of the coal production system. We feel that they should be managed on the basis of their ownership system, which is to say that rural and small town coal mines should be managed as rural and small town enterprises. They have a close relationship with readjustments in industrial structures and speeding up the peasants' movement toward wealth. This is the essence of the dynamism and vitality that should be developed substantially in rural and small town coal mines. The growth and great development of rural and small town coal mines shows that management in the rural and small town enterprise system is basically good and that in the future they should be brought onto the path of scientific management. Of course, there are cases in some areas and rural and small town enterprise systems where there is chaotic management, a confusion of names, stealing and retaining expenses and so on that must be rectified conscientiously. In addition, rural and small town coal mines should accept unified professional management, but the professional management should be unified, coordinated, service-oriented and supervisory. It should not change the nature of ownership systems and original jurisdictional relationships, it should not involve changes in manpower, finances or materials, it must not interfere with their rational benefit distribution, and it must strive to prevent changes in jurisdiction as well as egalitarianism and indiscriminate transfer of resources. We must take care to protect the initiative of the millions of peasants.

3. Detachment of production and shipping should be resolved. There must be a process of readjustment if the state is to shift the focus of investments to construction in communications and transportation. Railway construction takes an even longer building process, so coal development in Shanxi at the present time will continue to be restricted by shipping capacity. An urgent task now is to make obvious breakthroughs in highway transportation construction within a short period of time, but there also is an apparent lack of strength in deployments and investments in this area. Moreover, some comrades have emphasized the use of coal to develop coal in planning the development of rural and small town coal mines, using the benefits from coal only for construction at the mine itself. If done in this way, then perhaps 10 or so years in the future we would encounter a situation in which, as it does today, transport restricts production and the second breakdown in the link between production and sales would follow closely behind the first breakdown in the link between production and sales. We must strive to avoid this sort of situation. I suggest, therefore, that the state make a decision concerning trunk highway construction. Most of the trunk roads for shipping coal out of Shanxi lie within the province's boundaries. They require a large amount in state investments and inclusion in state plans, and they should be handled as key project items. I propose that state planning departments adjust to the new strategy for energy resource development and implement measures that focus on communications and give the capital that becomes available through reductions in fixed assets at coal mines to communications departments. If the situation persists where highways are used to develop highways in highway construction and the shortage of investments, and if

we do not include trunk highways in key project construction, then any major breakthroughs in using highways to ship coal out of Shanxi would be impossible. Doing so would make it hard to achieve the basic requirements that the new strategic principle must attain. If there is good matching transportation construction by other departments, the collection and shipping conditions within Shanxi certainly would be improved very quickly. The rural and small town coal mines also should withhold appropriate accumulations to build local branch highways and small communications and shipping facilities. The financial strengths of the people and the state should work together to open up a transportation network to ship coal out of Shanxi.

III. Old Concepts Must Be Changed

Adherence to the principle of implementing a new strategy in coal mine development requires attention to survey research on new situations and new problems for conscious destruction of the fetters of old concepts and "leftist" ideologies.

An important prerequisite for construction of the modern Shanxi energy resource base area is the achievement of specialization and a distribution of labor, multiple channels for production, shipping and marketing, and diversification. Various economic forms should coexist within a division of labor and mutual cooperation in large, medium and small structures of different scales, at different layers of the state, localities, townships and small towns and in different links among production, shipping and marketing so that the base area becomes a socialized production, shipping and marketing system. This is the primary indicator of a developed commodity economy and modernization.

For more than three decades, however, people have held the traditional view that modernization is equivalent to large scale state-run mines and that rural and small town enterprises, rural and small town coal mines and so on are the same as petty production. This is a mistaken understanding of modernization. The ownership system and scale of an enterprise have no inevitable relationship to the technical progress situation or to the level of production. Large enterprises have the advantages of large enterprises and small enterprises have the advantages of small enterprises. Either can achieve good economic results by managing scientifically and exercising proper leadership. The level of economic results is a primary indicator for evaluating the level of modernization in an enterprise. The developmental trend of enterprises in the developed nations toward smaller size and greater dispersion and our practice in the development of rural and small town coal mines in Zuoyun County have proven that it is possible that small enterprises and rural and small town coal mines might be rather backward in the early stages of their development, but that nevertheless they have progressiveness and high results that are in no way inferior to large enterprises and large mines if they are placed on the correct route of production, and they can flourish in the competition. We must take full note of the future for scientific management in rural and small town coal mines.

The influence of some old concepts includes the idea that transformation and improvement in rural and small town coal mines is "transitional" and that the ultimate goal is "state-run," making the process of technical progress the equivalent of upward movement in level of ownership. The effects of this "leftist" ideology during the mid-1970's was to cause a continual expansion and upward movement of accounting units in agriculture. The result was enormous destruction in the development during the rural reforms that followed the 3rd Plenum of the 11th CPC Central Committee, and we must continue to eradicate its influence in construction of the Shanxi energy resource base area. Rural and small town mines, small mines and state-run unified distribution mines and large mines alike can use technical transformation to become modernized mines, but this does not mean that the nature of ownership systems also changes. Errors of indiscriminate transfer of collective property have occurred in coal production, shipping and marketing systems in Shanxi Province, and the employees of some local mining companies have changed from "collective" to "whole people," so they are quite pleased with the indiscriminate transfer. We hope that this sort of thing does not happen again in the future. We believe firmly that the coexistence of economies with different ownership systems for a long period will cause large, medium and small mines to advance side by side. Moreover, rural and small town mines should not copy unchanged the models used in state-run mines, but instead should make their own characteristics the foundation and begin with economic results to adopt advanced technologies and other factors of production that are adapted to and match rural and small town mines.

There also is another old viewpoint that considers "variety" to be chaotic and is accustomed to unifying everything under heaven, meddling in everything and clamoring about from beginning to end. A centralized structure with a structure that organizes everything from top to bottom is made the outline of "reform" and the plan is to use this structure to implement unified management of coal production, shipping and marketing. This sort of idea is not adapted to the overall direction of reforms in economic systems in urban areas and rural reforms. Reforms in economic systems involve a transition from the crystallized system model at the present time to a completely vigorous and vital system model and the establishment of a new economic system with a fully developed planned commodity economy. During this process, there should be microeconomic spatial vitality, widespread development of horizontal linkages in the economy and an increasingly larger role for markets. Relatively speaking, vertical controls with a degree of centralization, a predominance of directive planning and reliance on administrative orders should be weakened and there should be reforms. Management of coal production, shipping and marketing in Shanxi must take the road of multiple channels, multiple layers and decentralization if it is to be opened up and made dynamic and if it is to achieve high rates and high results. Of course, but macrolevel controls should not depend primarily on the directives and orders of vertical structures. Instead, it should rely on guidance plans and utilize value,

taxation, credit and other economic levers, and it should establish laws, rely on associations and implement "integration of unification and decentralization." "Unification" refers to unified planning, unified prices and unified strategic coordination. It is not unified management or unification of all manpower, finances and materials. "Decentralization" refers to decentralized management by thousands of production, shipping and marketing enterprises under unified plans and professional guidance, like the Eight Immortals crossing the sea, each one showing his or her special prowess.

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COAL

PROSPECTS FOR CWM-FBC TECHNOLOGY EXPLORED

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[Article by Cen Kefa [1478 0668 3127], Ni Mingjiang [0242 2494 3068], Huang Guoquan [3385 0948 2938] and Luo Zhongyang [7482 0112 3142]]

[Text] Abstract

This article reports on a new coal-water mixture--fluidized-bed combustion [CWM-FBC] technology. Experiments have confirmed that this technology is capable of stable combustion of a coal-water mixture of different grades, water contents and particle sizes with relatively high thermal efficiency. The technology can assure relatively low NO_x discharge and effective desulfurization. For this reason, CWM-FBC technology has excellent prospects for application in the processing and utilization of CWM discharged by various industrial departments.

I. Preface

Coal is China's primary energy resource. A great deal of CWM often must be discharged by many industrial departments during the technical processes of extracting, shipping, processing and utilizing coal.

The primary source of CWM is coal dressing plants. China's coal dressing plants now discharge about 6 million tons of coal washing slurry each year. Moreover, hydraulic coal extraction and other technologies can produce a low thermal value CWM. China already has plans to build a demonstration coal transmission pipeline.

Industrial development brings with it an ever-increasing demand for coal, and the amount of CWM discharged by these departments also can grow continually. This CWM often contains substantial amounts of very fine coal and it has rather strong water retentiveness. If processed inappropriately, it not only could lead to substantial losses of energy resources but could create serious environmental pollution as well. Can this type of CWM be burned directly within boilers? If possible, this undoubtedly would be the optimum processing method.

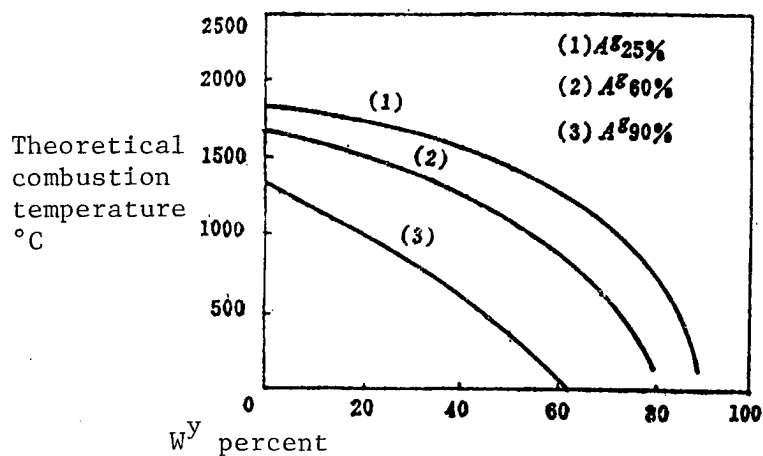
There are many technologies for burning CWM. The advantages of FBC technologies in the areas of high heat reserves and high heat conversion coefficients offer rather good prospects for their use in burning CWM. Below, we first of all will analyze the effects of water content on the operation of fluidized-bed boilers and energy utilization. Next, we will describe our research on CWM-FBC technology and finally report on the results of some experiments.

II. The Effects of Water Content on Fluidized-Bed Operation

Figure 1 shows the theoretical combustion temperature of a CWM composed of different coal contents under different water contents. Figure 1 shows that when the water content is 30 percent, a CWM made of coal with an ash content of 60 percent (dry base) has a theoretical combustion temperature of 1,400°C. Even deducting for combustion losses, heat dissipation losses and a consideration of theoretical pipe heat absorption, it is completely possible to maintain rational bed temperatures during fluidized-bed combustion at a constant bed temperature around 900°C. A CWM with a 90 percent ash content (dry base), however, has a lower water content of 20 percent. The theoretical combustion temperature is only around 1,000°C, so it would be hard to maintain a constant bed temperature in such a case. For this reason, the dry base ash content of the coal should be around 60 to 70 percent when lower heat value CWM is used to assure bed temperature angles.

Figure 1.

The Influence of Water Content and Ash Content on the Theoretical Combustion Temperature of a Coal-Water Mixture



Another effect of water content is that the evaporation of the water content delays the ignition time of the CWM. Evaporation theory permits us to calculate the water content evaporation time for CWM drops of different sizes under different water contents. The results are shown in Figure 2. The chart shows that the evaporation of the water in liquid CWM with a diameter of 10 mm and a water content of 50 percent only prolongs the ignition time by about 20 seconds. This is two numerical grades lower than the retention time in the fluidized-bed boiler, so delayed ignition caused by evaporation has no real effects on the combustion of CWM within fluidized-bed boilers. A large amount of water entering the fluidized-bed, however, could affect the stability of bed temperatures. Figure 3 shows the maximum values of bed temperature varia-

tion during the process of igniting CWM with different water contents under normal fluidized-bed conditions. According to the experiments, the ignition times of liquid drops of a CWM with a diameter of 10 mm and a water content of 30 percent consistently are less than 20 seconds. We can learn from Figure 3 that, even under the extreme conditions of abruptly dumping CWM into a fluidized-bed boiler during normal operation, the bed temperature variation that results during the 20 seconds is relatively small.

This analysis has shown us that the particularly favorable conditions of direct combustion of CWM in fluidized-beds can be adapted to lower heat value CWM and that this can overcome negative factors caused by the movement of large amounts of water into the boilers such as lowered combustion temperatures, delayed ignition, variable bed temperatures and so on, and that it also can provide the condition for stable operation.

Figure 2.

Evaporation Time for Droplets of Coal-Water Mixture of Different Diameters under Different Water Contents

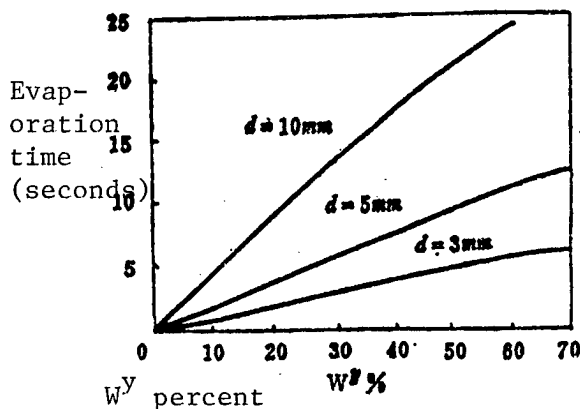
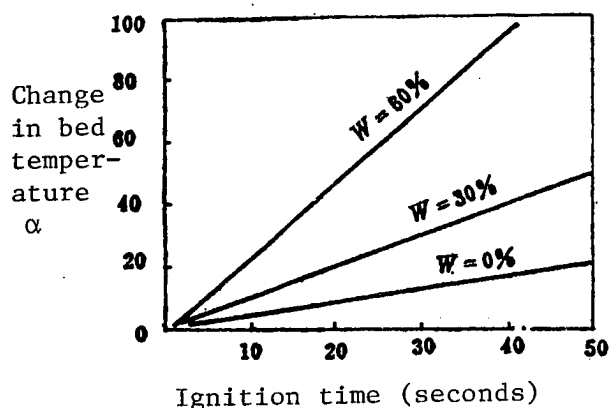


Figure 3.

The Influence of the Ignition Process on Bed Temperatures

III. Effects of Water Content on Energy Utilization

The temperature of smoke now discharged from boilers always exceeds 100°C. This means that the water in the CWM is discharged from the boiler in the form of steam along with smoke and gases. This steam carries a substantial amount of energy in the form of vaporized latent heat. Figures 4 and 5 show the latent heat losses and the amount of available energy created by the water content per kilogram of dry base. We can see in Figures 4 and 5 that latent heat loss increases as the water content of the CWM increases, and that the losses increase dramatically when the water content is around 40 to 50 percent. As for the available energy component, besides that related to the water content, there is some that is related to the amount of heat generated (dry base) by the coal that forms the CWM. For coal where $Q_{dw}^g = 6,000$ kilocalories/kg,

the available energy component is 90 percent when $W^y = 50$ percent. When $Qg_{dw} = 1,000$ kilocalories/kg, the available energy component drops to 40 percent. When the water content of this type of coal reaches 62.5 percent, the available energy component changes to zero, meaning that this type of CWM could provide no energy for the boiler to use after it was placed in the boiler.

Figure 4.

Latent Heat Losses at Different Water Contents

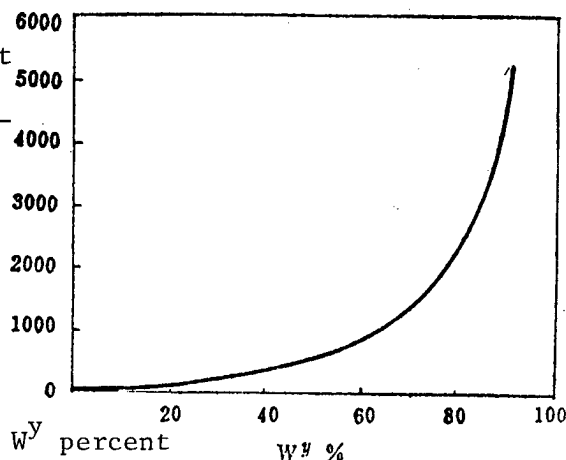
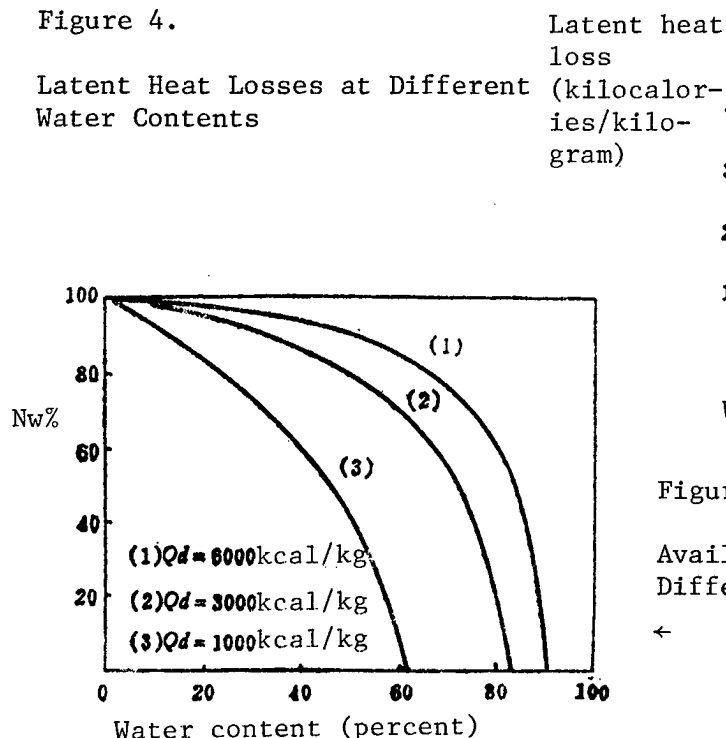


Figure 5.

Available Energy Component under Different Water Contents

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To reduce the loss of latent heat and increase the available energy component, the lower the amount of water in the CWM the better. This, however, requires intensive dehydration of the CWM. Besides the increased installation of dehydration equipment, it also requires the consumption of manpower and finances, the consumption of energy and other expenses. For this reason, starting from the perspective of energy utilization to determine the most appropriate water content for CWM placed in boilers is a question of the technical economics between available energy component and dehydration costs.

The calculations show that for coal with a large water content, the available energy component that is recovered through dehydration is obviously greater than the former costs of consumption during the mechanical dehydration process. If, for example, we use a centrifugal filter press to concentrate liquid coal washing slurry from a coal dressing plant with a water content of 75 percent (the typical water content at the outlet of a rake-type concentrator) to 25 percent, the recovered available energy component is 1,600 kilocalories/kilogram, while the energy consumed in the filter press is less than 10 kilocalories/kilogram. There is hope from the energy utilization perspective, therefore, that the mechanical dehydration method can be used. The regrettable

thing is that existing mechanical dehydrators are only capable of reducing the water content of fine particle CWM to around 20 to 30 percent, and it becomes very difficult to reduce the water content any further. Moreover, there are limits to the amount of energy that can be recovered (as shown in Figure 4). It should be mentioned that if the CWM could be burned directly in boilers, then thermodynamic drying becomes an undesirable drying method. The reason is that the amount of heat consumed by the thermodynamic dryer may be much greater than the amount of energy recovered. If the water content of the CWM is too low, however, there may be a drop in combustion efficiency. For this reason, a water content of 20 to 30 percent is the most suitable for fluidized-bed combustion. Figure 4 shows that within this range of water contents the energy consumed by the water is not that great.

IV. A Brief Introduction to CWM-FBC Technology

One extremely important aspect of fluidized-bed combustion of CWM is condensation and clumping. The CWM that is placed in the fluidized-bed is composed of coal powder. After the coal is dried internally, it does not revert to single particles of coal powder but instead forms solid clumps. The view of most researchers at present is that the condensation and clumping places combustion efficiency in opposition to operational stability.^{1,2,3} The result is that the weak points of poor stability, lower combustion efficiency and low heat intensity are common. We feel that condensation and clumping are the foundation for organizing the combustion of fine particle coal (powder) CWM, and we provide a simple and easy technique to achieve this. The key points are that it uses feeding of molded material and makes full use of the condensation and clumping to reduce losses from lifting and separating the fuel for the condensed clumps with rather large particle diameter that form in the CWM within the bed. The use of a large proportion of durable, cheap and easily obtainable material as a bed material to prevent the accumulation of large condensed clumps creates the conditions for stable operation. The adoption of a no-spill operational pattern to reduce the wastage of heavy material will extend the time that the condensed clumps remain in the bed and improve the degree of full burning.

V. Applications of CWM-FBC Technology

Several realms for the application of CWM-FBC technology were explored in two experimental hot fluidized-bed combustion testing platforms in Zhejiang University's Combustion Laboratory. The bed area of the experimental boilers was 250 x 250 mm and 500 x 500 mm. Figure 6 is a simple diagram of the fluidized-bed combustion testing platform. The fuel, CWM, enters the fluidized-bed boiler from the top. The typical operational conditions were a bed temperature of 950°C, a hollow core speed of 0.7 m/sec (standard state) and a bed area heat intensity of 2.1×10^6 kilocalories/meter²/hour. See sources 4 and 5 for a detailed outline of the experimental boiler.

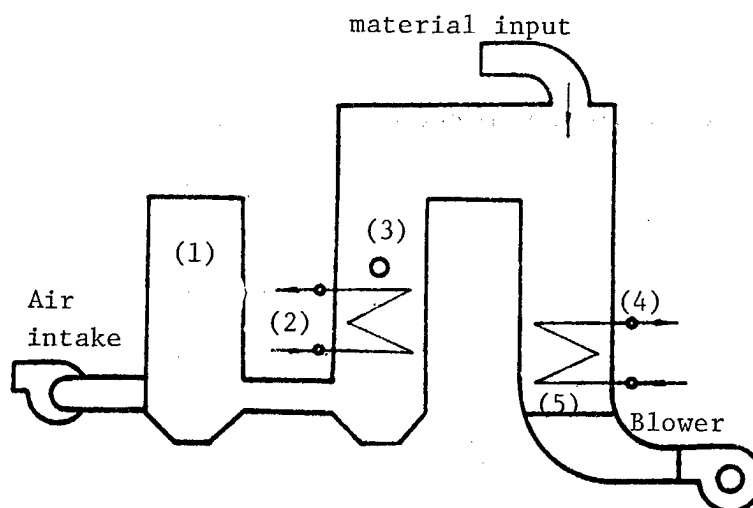
The experimental results we have obtained so far are reliable and indicate that CWM-FBC technology has very great use value in at least the following areas.

Figure 6.

The 500 x 500 mm Combustion Testing Platform

Key:

1. Bag-type dust remover
2. Cooling water
3. Combustion loss measurement point
4. Buried pipe to bring in water
5. Air distribution plate



1. Coal slurry recovery from coal washing plants

The low heat value and strong water retentiveness of coal slurry make it extremely difficult to utilize. Many coal washing plants now simply discard and do not use the coal slurry. Dealing with it improperly not only can create serious environmental pollution but also can result in the loss of large amounts of energy. The coal slurry now discharged by China each year, for example, is equivalent to 2 to 3 million tons of high quality coal. We carried out a series of combustion experiments to recover this coal washing slurry and used dressed coal slurry from the Sichuan Province Yongrong Coal Mining Bureau coal washing plant in the experiments. Data on the typical analysis are shown in Table 1.

Table 1. Typical Analytical Data for Yongrong Coal Slurry

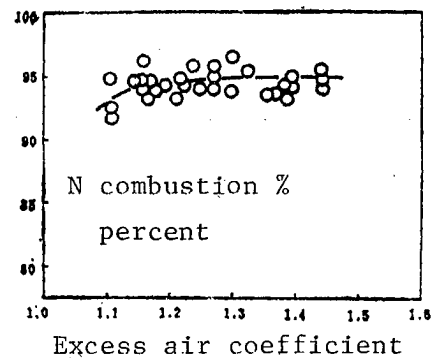
$W\%$	$A\%$	$V\%$	$C_{GD}\%$	Q_{DW} kcal/kg	d mm
25	52.1	17.1	30.8	2506	0~0.9

Figure 7 shows the results of combustion efficiency experiments during fluidized-bed combustion of the coal washing slurry from the Yongrong Mining Bureau. Figure 7 shows that the combustion efficiency averaged about 95 percent, which is much higher than the combustion efficiency for conventional fluidized-bed combustion of poor quality coal.

A 10 ton/hour coal slurry fluidized-bed combustion demonstration power plant boiler now is under construction and it is predicted that it will go into operation within a year.

Figure 7.

Combustion Efficiency during
Fluidized-Bed Combustion of
Yongrong Coal Slurry



2. Fluidized-bed combustion of CWM shipped in coal transmission pipelines

CWM shipped in coal transmission pipelines has a rather large coal particle size. To facilitate start-up and reduce precipitation, a substantial proportion of fine powdered coal (about 20 percent) must be added. This fine powder is very difficult to separate from the water. Fuel losses at the (Heimisa) coal transmission pipeline in the United States, for example, reached 9 percent as a result of the inability to dehydrate the fine powder. To study whether or not CWM-FBC technology can use CWM with different particle sizes and different water contents, we tested three different types of CWM. Some analytical data for these CWM are shown in Tables 2 and 3.

Table 2. The Coal-Water Mixture Mixed from Bijiangang Coal

$W^{\circ}\%$	$A^{\circ}\%$	$V^{\circ}\%$	$C_{GD}^{\circ}\%$	Q_{DW}° kcal/kg	d mm
25	20	31.3	48.7	4510	0~2 2~5

Table 3. The Coal-Water Mixture Mixed from Datong Coal

$W^{\circ}\%$	$A^{\circ}\%$	$V^{\circ}\%$	$C_{GD}^{\circ}\%$	Q_{DW}° kcal/kg	d mm
40~75	27.1	23.1	49.8	3910~1010	0~0.2

The results of combustion efficiency tests for CWM composed of coal 0 to 2 mm and 0 to 5 mm in size at Bijiangang are shown in Figure 8. Figure 8 shows that when the excess air coefficient is greater than 1.2 hours, the combustion efficiency consistently was greater than 95 percent under the second type of conditions. Figure 9 shows the test values for fluidized-bed combustion of CWM composed of coal powder 0 to 0.2 mm in size. The tests showed that normal combustion still is possible for a CWM with a 70 percent water content and moreover that the combustion efficiency is greater than 96 percent. During combustion of CWM with a high water content, hot air must be provided to

guarantee adequate bed temperatures. It can be seen clearly from the experiments concerning combustion efficiency that CWM-FBC technology is not sensitive to the size and water content of the coal particles in the CWM.

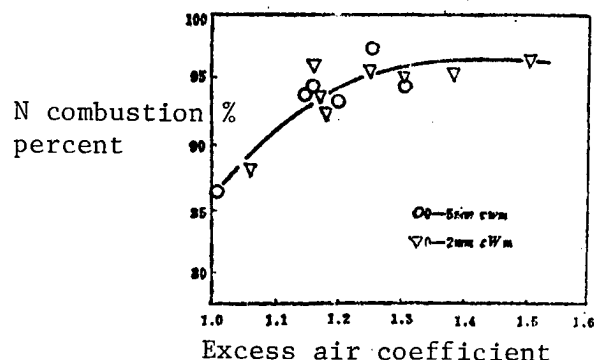


Figure 8. The Combustion Efficiency of Coarse Coal Powder CWM

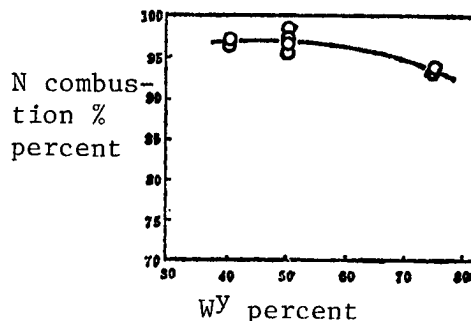


Figure 9. The Influence of Water Content on CWM Combustion Efficiency

The combustion efficiency provided here can be compared with the combustion efficiency of coal powder, which can permit further improvements in CWM-FBC technology that would allow to become an ideal technical method for the final processing of CWM from coal transmission pipelines. The reason is that it can simplify and even eliminate certain final processing techniques now in use like intensive dehydration, thermodynamic drying, grinding and so on.

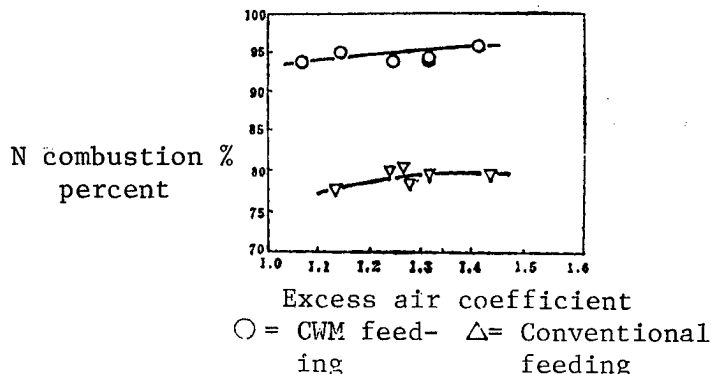
3. Improved combustion efficiency for wide-screen feeding in fluidized-bed combustion

The main problem faced by wide-screen coal feeding for fluidized-bed combustion in China is that the combustion efficiency is too low. The main combustion loss arises from the lifting and separation of the fine coal particles. The coal used in most fluidized-bed boilers in China typically has a particle size of 0 to 8 mm, including 20 to 40 percent fine powder smaller than 0.5 mm. Lifting and separation losses from this can reach 15 to 25 percent. The results of the present experiments show that CWM-FBC technology can be used to burn CWM composed of fine coal particles with high efficiency. Some additional experiments were done to improve the combustion efficiency of wide-screen feeding in CWM-FBC technology. The wide-screen feeding used in the experiments was divided into two grades, 0 to 2 mm and 2 to 5 mm. The 2 to 5 mm coal particles were fed into the boiler in a conventional manner, while the 0 to 2 mm coal particles first were mixed into a CWM and then used as a special feed and sent into the boiler. For comparison, the combustion efficiency of unsized (0 to 8 mm) wide-screen separation of the coal powder was measured while using conventional feeding patterns. The combustion efficiency using the second feeding method is shown in Figure 10. Figure 10 shows that the combustion

efficiency during unsized wide-screen feeding was 79.6 percent while the combustion efficiency of sized feeding for fine material CWM used for feeding reached 94.3 percent. Of course, some latent heat loss may occur from feeding the fine material as CWM, but such losses are relatively limited. Using the types of coal in the experiments as an example, coal powder smaller than 2 mm accounted for about 50 percent, which means that turning this fine powdered coal into a CWM with a 25 percent water content is equivalent to a wide-screen feed material with a water content of 14 percent. The latent heat loss at this time according to calculations using formula 3 was 1.6 percent. It is obvious that the amount of energy recovered by improved combustion efficiency is far greater than the latent heat loss caused by the added water.

Figure 10.

Comparison of Combustion Efficiency
with Two Feeding Patterns



4. Controlling the amount of pollutants discharged into the atmosphere

We know that fluidized-bed combustion can control effectively the amount to pollutants discharged into the atmosphere. Our experiments confirmed that fluidized-bed combustion of CWM can control effectively the amount of pollutants discharged into the atmosphere and that the results sometimes are very good.

Figure 11 compares the amount of NO_x discharged during fluidized-bed combustion of CWM and dry coal. We can learn from Figure 11 that the amount of NO_x discharged during fluidized-bed combustion obviously is less than during the burning of dry coal. The reasons are not entirely clear at present. It is possible that the reduced air produced during the gasification reaction of H_2O and C can cause a oxidation reaction of the N.

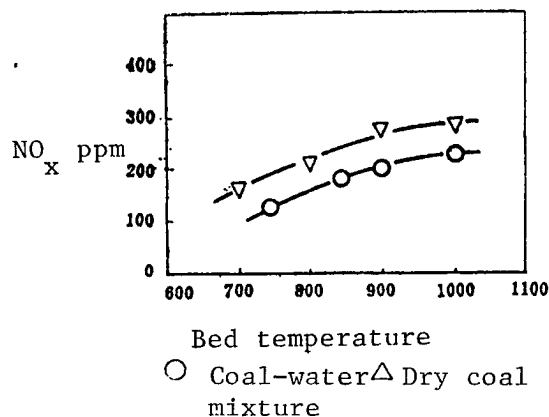


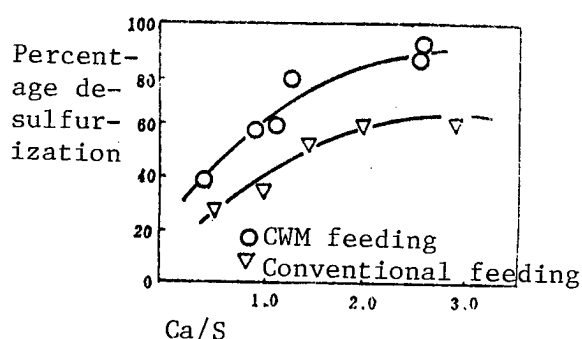
Figure 11.

Amount of NO_x Discharged by Dry Coal
and CWM

Two methods were used during the desulfurization experiment. The method used for drying was one commonly used at the present time in which the dried desulfurization agent is added directly to the fluidized-bed. In the method used for the CWM, however, the desulfurization agent first of all was added to the CWM and mixed evenly with it, after which the coal-water-desulfurization agent mixture was sent into the bed. At that time, the CWM in the bed formed concentrated clumps composed of the fuel and the desulfurization agent. In this manner, the time that the desulfurization agent remained in the bed was equal in length to that of the fuel. In addition, there was an extremely good mixture of the coal and desulfurization agent and they could come into direct contact, so it was possible to carry out desulfurization inside the bed. The results of the experiments shown in Figure 12 show that the results of the desulfurization method used for the CWM obviously are much better than conventional desulfurization methods.

Figure 12.

Comparison of Two Desulfurization Techniques



5. Gasification using fluidized-bed combustion

The exploratory experiments indicated that the main techniques employed in CWM-FBC technology also could be used for gasification through CWM combustion. Water and coal gas with a heat value of 1,200 kilocalories/standard cubic meter already has been obtained successfully by using gas as a medium under normal pressure conditions.

VI. Conclusions

The characteristics of the concentrated clumps based on CWM provide a new technology for fluidized-bed combustion of CWM. The experiments show that the techniques described in this article can be used to burn CWM composed of different ash contents, different water contents and different particle sizes, and moreover that the combustion efficiency is rather high. It is convincing that CWM-FBC technology has very great use value in many realms. The basic theory of CWM-FBC technology and research on applied technologies now is developing intensively at the Zhejiang University Combustion Laboratory.

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12,539/8918
CSO: 4013/167

COAL

BRIEFS

'85 OUTPUT: 847 MILLION TONS--Beijing, 1 Jan (XINHUA)--China produced 847 million tons of coal in 1985, a 9.78 percent increase over the 1984 figure according to the Ministry of Coal Industry here today. Nearly half was produced by local mines which reported a 14.1 percent increase over 1984 while the output of mines under the administration of the ministry increased by 5.64 percent. Local coal mines include mines run by provinces, prefectures, counties and collectives or by local peasants and other individuals. The development of local mines has greatly reduced the strains on China's major coal mines and helped rationalize the geographical distribution of energy, meet the needs of local industrial and agricultural production, and enliven local markets, according to the ministry. [Text] [Beijing XINHUA in English 0848 GMT 1 Jan 86 OW] /8918

EXPORT FIGURES REVISED--Beijing, 14 Jan (XINHUA)--China exported 7.567 million tons of coal in 1985, an all-time high, according to today's PEOPLE'S DAILY. Over half of the exported coal was produced in Shanxi and Hebei provinces, the country's leading coal producers. Last year, Japan was the largest importer of coal from China, followed by the Democratic People's Republic of Korea. China produced 847 million tons of coal in 1985. By 1990, the figure is expected to exceed 1 billion tons. [Text] [Beijing XINHUA in English 0646 GMT 14 Jan 86] /12223

PINGSHUO UPDATE--Since the Pingshuo Antaibao open-pit coal mine opened on 1 July of this year, strip mining work has been advancing quickly. By the end of September, the amount stripped totalled 2.01 million cubic meters, or 61 percent of the annual plan, and it is anticipated that the annual target will be exceeded. After going into operation, the mine has been receiving and assembling equipment and carrying out professional and technical training, and it has also been engaged in excavating and stripping. The 13 metallurgical construction companies and three bureaus of the MWREP that have been contracted for the stripping project have raced against time, and the amount stripped has exceeded 200,000 cubic meters a day. This has compelled the mine's industrial project and living facilities to accelerate construction. [Text] [Beijing ZHONGGUO MEITAN BAO in Chinese 19 Oct 85 p 1] /9604

HUGE XINJIANG RESERVES--Xinjiang now has proven coal reserves of 18.3 billion tons and estimated reserves of 1.6042 trillion tons, the largest in the nation. In more than 30 years, geological prospectors have left their footprints in every coal field, and found a large number of coal fields that could be built into mines or that could be surveyed further. At the present time, the state's capital construction investment in Xinjiang's coal industry totals 550 million yuan: 51 mines have already been improved, expanded, or newly built, of which six are large- or medium-sized shafts that yield more than 300,000 tons per year, and the Hami open-pit coal mine which has a planned capacity of 1.5 million tons is the largest open-pit coal mine in northwest China. Currently, 276 mines greater than 30,000 tons have been built in Xinjiang, and more than 200 small rural and township mines have also been built. More than 60 of the province's counties and towns have begun to operate coal mines. In 1984, the province produced 14.33 million tons of coal, a 78.6-fold increase over the 1949 figure of 179,800 tons. Today, 4 days of coal production exceeds the entire total of 1949. [Text] [Beijing JINGJI RIBAO in Chinese 2 Oct 85 p 3] /9604

HEILONGJIANG LOCAL MINE OUTPUT--As of 15 November, collieries run by local units throughout Heilongjiang Province turned out 16.38 million tons of raw coal and prefulfilled their annual production plans by 46 days, showing a 19.7 percent increase over the figure for the corresponding 1984 period. [Excerpt] [Harbin HEILONGJIANG RIBAO in Chinese 23 Nov 85 p 2 SK] /9738

HEBEI EXCEEDS 1985 PLAN--The coal industrial departments of Hebei Province prefulfilled the annual raw coal production plan by 52 days. As of 20 November, the province overfulfilled the annual raw coal plan by 6.09 million tons, an increase of 9.6 percent over the corresponding period of last year. The local collieries of the province had prefulfilled the annual raw coal production plan by 3 months. So far, these collieries had overfulfilled the annual production plan by 4.37 million tons. [Excerpts] [Shijiazhuang HEBEI RIBAO in Chinese 30 Nov 85 p 1 SK] /9738

XINJIANG 6TH FYP OUTPUT--Xinjiang produced a total of 65 million tons of coal during the Sixth Five-Year Plan, an increase of 30 percent over the figure for the previous plan. Some 9.5 million tons were shipped out of the region during the 5 years of the plan, 70 percent more than in the previous 5 years. There are now 767 local coal mines in the region, compared with 484 in 1980, and their output accounts for 73 percent of total output. [Summary] [Urumqi Xinjiang Regional Service in Mandarin 1300 GMT 28 Dec 85 HK] /9738

GANSU 1985 OUTPUT--Gansu has produced 11.7 million tons of coal this year, double the figure for 1980. The province reached the Sixth Five-Year Plan target 2 years ahead of schedule. [Summary] [Lanzhou Gansu Provincial Service in Mandarin 1100 GMT 29 Dec 85 HK] /9738

QINGHAI BOOSTS OUTPUT--Qinghai scored remarkable successes in coal output this year. According to statistics, by the end of November, the province's output of raw coal totaled over 2.4 million tons, overfulfilling this year's target 1 month ahead of schedule. Compared to the same period last year, the mines directly under the provincial authorities increased the output of raw coal by over 134,000 tons. Various prefectural, county, town, and township mines also developed rapidly. By the end of November, they had produced 858,000 tons of raw coal, accounting for 34.7 percent of the province's gross output of raw coal. [Summary] [Xining Qinghai Provincial Service in Mandarin 2330 GMT 16 Dec 85 HK] /9738

NEW GUJIAO SHAFT--Work on a large-scale mine with a design annual capacity of 4 million tons of coal--the Dongqu mine of the Gujiao mining district of the Xishan Mining Bureau in Shanxi Province--officially began on the 25th. This is the fourth pair of large-scale mines to be started in the Gujiao district. Gujiao is now constructing mines with a capacity of some 12.5 million tons. This mine will be built at a total cost of some 320 million dollars U.S., and is expected to go on stream at the end of 1989. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 27 Sep 85 p 1] /12232

LOCAL MINES AHEAD OF SCHEDULE--By the end of September, Hebei Province's local mines had produced a total of 14.57 million tons of raw coal, exceeding the plan by 70,000 tons and completing the annual state plan 94 days ahead of schedule. This is a 16 percent increase compared to the same period last year. [Text] [Shijiazhuang HEBEI RIBAO in Chinese 9 Oct 85 p 1] /12232

MORE ROLLING STOCK FOR QITAIHE--Recently, the Ministry of Railways specially assigned Qitaihe 200 cars in order to transport its overstocked coal. As of 13 September, 140 cars were transporting coal to the station, and in 6 days they transported a total of 16,140 tons of raw coal. This year, Qitaihe's state mines plan to produce more than 5.5 million tons of raw coal, and local mines plan to produce 5.15 million tons of raw coal. The rapid increase in coal has aggravated the railroad transportation burden, and there has been a serious deficiency of rail cars. The amount of coal overstocked at Qitaihe has reached a record level, of which more than 11 million tons is from state mines and more than 27 million tons is from local mines. Some state mines have been forced to halt production, and 70 percent of all local mines have either had to halt or cut down production. [Text] [Harbin HEILONGJIANG RIBAO in Chinese 29 Sep 85 p 1] /12232

ANHUI COAL BASE EXPANSION--During the Sixth Five-Year Plan, the Huainan-Huaibei Coal Base in Anhui Province expanded and stepped up construction. From 1981 to the end of this year, it is expected that a total investment of 2.03 billion yuan will have been committed, or 2.2 times that committed during the Fifth Five-Year Plan. Eleven new coal pits, with a total designed production capacity of 20.5 million metric tons, were built over the past 5 years for an added production capacity of 6.6 million metric tons. [Summary] [Hefei Anhui Provincial Service in Mandarin 1100 GMT 21 Nov 85 OW] /6662

HENAN INCREASES OUTPUT--After fulfilling the Sixth Five-Year Plan's coal output target 2 years ahead of schedule, the province further developed production. By 9 December it had produced 70.06 million tons of raw coal. During the Sixth Five-Year Plan period, the province's output of raw coal was increased at an annual growth rate of over 3 million tons and the province still ranked second in China in terms of annual output volume. [Text]
[Zhengzhou Henan Provincial Service in Mandarin 1030 GMT 11 Dec 85 HK] /6662

CSO: 4013/37

OIL AND GAS

1985 CRUDE OUTPUT FIGURES REPORTED

OW021523 Beijing XINHUA in English 1454 GMT 2 Jan 86

[Text] Beijing, 2 Jan (XINHUA)--China produced 124.8 million tons (about 911 million bbl) of crude oil last year, or 23.5 million tons more than in 1981, XINHUA learned from the Ministry of Oil Industry here today.

During the Sixth Five-Year Plan (1981-1985), the average annual increase of oil output was 5.3 percent.

From 1981 through 1985, the oil industry provided an additional 51 million tons (352 million bbl) of commercial oil to the country.

In the 5 years, a number of important oil discoveries were made, including several oil fields whose geological reserves surpassed 100 million tons (730 million bbl) each, and big discoveries of oil and gas were made in more than 30 areas.

With these discoveries, the added reserves in the 1981-85 period were 50 percent greater than that in the preceding 5 years, thus laying a good foundation for a steady increase of oil output in the coming years, the ministry said.

China's largest oil producer--Daqing--pumped more than 55 million tons (401 million bbl) of crude last year, or 4 million tons (29 million bbl) more than in 1981, although water content had increased in the oil.

The Shengli oil field, China's second largest, turned out over 27 million tons (197 million bbl) in 1985 as against 16 million tons (117 million bbl) in 1981.

Over the past 5 years, the industry turned over 32.24 billion yuan in profits to the state, 2.5 times more than the state investment in the industry in the same period.

/8918

CSO: 4010/25

OIL AND GAS

CRUDE OIL OUTPUT GROWS BY 10 MILLION TONS IN 1985

HK030811 Beijing CHINA DAILY in English 3 Jan 86 p 1

[By staff reporter Xu Yuanchao]

[Text] China's oil industry registered strong growth in 1985 with crude output reaching 124.8 million tons and natural gas 12.7 billion cubic meters, Petroleum Minister Wang Tao said.

Last year's output for crude oil exceeded the 1984 total by 10 million tons, Wang told CHINA DAILY in an exclusive interview in Beijing. Five major targets set in the Sixth Five-Year Plan (1981-1985) were also exceeded: the output of crude oil exceeded the target by 9.7 percent; natural gas production by 23.2 percent; production capacity for oil by 39.3 percent; well-drilling by 24.2 percent; and investment by 0.9 percent.

Wang said that the Seventh Five-Year Plan, starting this year, would be critical for the industry. The annual production for crude oil was expected to reach 150 million tons by 1990 and natural gas 15 billion cubic meters.

Meanwhile, Wang said, a management system suitable for China's oil industry would be established to lay a firm foundation for rapid growth in the last 10 years of the century.

Since he became oil minister last June, Wang has inspected several oilfields. He said: "The Daqing oil field has produced 50 million tons of oil for 10 successive years and production will be able to last for another 10 years.

"The Shengli oil field will be expanded to an annual output of 50 million tons. Production capacities in Liaohe, Zhongyuan and Huabei oil fields will each be expanded to 10 million tons," he said.

Last year, Wang said, more than 30 areas with rich oil and gas accumulations were found in China. At least three large oil fields with reserves each exceeding 1 billion barrels were discovered in eastern China where the annual output accounts for 90 percent of the country's total.

He said that eastern China was the country's major oil-producing area where annual production would reach 140 million tons by 1990. At the same time,

exploration for oil and gas in western China would be speeded up in a bid to double the known oil and gas reserves in the next 5 years.

Several aspects of the industry will get special attention during the Seventh Five-Year Plan. Production of crude oil will be kept increasing steadily in the coming years, with an average growth rate of 5-6 million tons per year.

Gas production in Sichuan Province, in north China and in the Yinggehai Basin of the South China Sea will be increased and two other gas-producing areas, in the northeast and Shaanxi-Guansu-Ningxia border region, will be commercially developed.

China will further open to the outside world and strengthen its cooperation and technical exchanges with foreign countries to introduce advanced technology and equipment and train management and technical personnel, Wang said.

During the Sixth Five-Year Plan, China produced 548 million tons of oil at an annual average growth rate of 5.3 percent, providing an additional 51 million tons of commercial oil to the country. Profits and taxes paid to the state were expected to reach 32 billion yuan--equivalent to 2.5 times that of the investment made by the state in the same period.

Wang said the Tarim Basin in the Xinjiang Uygur Autonomous Region was the largest oil-bearing area in China and probably one of the largest in the world which has yet to be tapped. It has rich oil and gas reserves.

Two exploratory wells have been struck in the area. The output of crude oil for each of them has exceeded 1,000 tons and the natural gas output was about 2 million cubic meters.

The government felt it difficult to develop because of poor transport and communications, Wang said. But foreign oil firms expressed high interest in the area.

Wang said that foreign companies were welcome to make surveys and put forward their suggestions, but the investment required in the area would be "staggering."

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CSO: 4010/25

OIL AND GAS

\$8.5 BILLION COULD BE SPENT ON OFFSHORE EXPLORATION

HK270805 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS SUPPLEMENT) in English 27 Nov 85 p 5

[Article by Olivia Sin in Guangzhou]

[Text] As much as U.S.\$8.5 billion will be spent on China's offshore oil exploration development program by the end of the decade, according to a financial expert.

Dr D.F. Lomax, group economic adviser to National Westminster Bank, said the figure included \$1.5 billion spent during the past 5 years and another \$5 billion to \$7 billion for the 1986-90 period.

He said the \$8.5 billion figure is smaller than original estimates of \$20 billion because there have been fewer finds, reducing the need for a large development budget.

Dr Lomax told the Offshore China '85 exhibition and conference, which opened yesterday, that the \$5 billion to \$7 billion will cover the exploration costs in the second round of competitive bidding as well as what is needed to bring the oil and gas on stream in the South China Sea and the Beibu Gulf.

The level of investment in offshore China over the next decade remains a question mark because it depends on whether major discoveries are made, he said.

On the investment implications of the offshore development, Dr Lomax said the likelihood of finding giant oilfields has been reduced in light of disappointing results to date.

Two hydrocarbon developments have been planned in southern China over the next few years.

They are a \$500 million natural gas development being jointly carried out by China and the U.S.-based Atlantic-Richfield Co. in the Yinggehai Basin and a \$150 million oil development in Beibu Gulf.

The Beibu Gulf development is a joint venture between France's Total China and China.

Dr Lomax said about \$1.25 billion may be needed to develop the Agip-Chevron-Texaco find in the South China Sea.

The group has reported encouraging results but has not decided whether to go ahead.

Since China is regarded as an excellent credit risk, he said, it will not have trouble raising funds for its development program.

He said China and its foreign partners can consider using swaps of underwriting facilities in the international financial markets to raise funds for the program.

Nevertheless, he said, given China's tight timetable to quadruple its oil output by 2000 and the uncertainty of finding the oil, a top priority remains to ensure that there is enough investment in the short term to fully explore the vast China coast.

The initial investment program and strategic plan for offshore China must be flexible in view of the uncertainty over reserves, he said.

/6662

CSO: 4010/21

OIL AND GAS

FOREIGN OIL COMPANIES OFFERED NEW INCENTIVES

HK020505 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS SUPPLEMENT) in English 2 Dec 85 p 1

[From Olivia Sin in Guangzhou]

[Text] China is offering special terms and new opportunities to foreign companies which have so far failed to find oil off the Chinese coast.

A senior Chinese official, Mr Tang Xin, said in Guangzhou at the weekend that companies unsuccessful in the first round are being allowed to expand their original contract areas or seek new acreage to finish their drilling commitments.

Mr Tang, head of the contract and legal department of the Nanhai West Oil Corp (NWOC), said four oil consortiums are taking advantage of the preferential treatment. They are British Petroleum [BP] Occidental, Sun, and Idemitsu.

The four are among the 10 groups awarded contracts in the first round of bidding for exploration blocks in offshore China.

So far, only three groups--ACT (Agip, Chevron, Texaco), Phillips and Esso--have made encouraging discoveries.

Analysts said the special treatment marked a significant softening of China's stand in offshore oil activities.

It also reflected China's eagerness to sustain oil companies' interest amid poor results and falling oil prices.

"China does not want to see the companies withdrew from the country empty-handed," said an analyst.

Mr Tang said the BP-led group, after encountering a succession of dry wells, is looking for new areas in the Beibu Gulf.

The group obtained a total of five blocks covering more than 10,000 sq km in the South China Sea and Yellow Sea.

Under the original contracts, the group has to bear all the exploration risks and expenditures and complete a specified number of wells in the blocks. The number of wells involved remains secret.

Apparently, the BP group has lost interest in the five blocks and wants to transfer its remaining job requirement to a new area, which will lie somewhere north of Hainan Island.

Mr Tang said NWOC will try its best to help the BP group and provide it with seismic data free of charge.

"We will let them choose a new area provided it is not included in the second round now in session," he said, adding that BP has not yet made up its mind.

If BP decides to take up the offer, a new contract written in the same terms as the first round will be signed.

Similarly, Occidental is looking for new opportunities in offshore China after failing in four attempts to find oil in the South China Sea.

Occidental suspended its operations in China last year and may resume work next year.

Both Sun and Idemitsu have recently signed contracts to expand their areas in Beibu Gulf in the hope of finding better prospects.

Mr Tang admitted that, legally speaking, China does not have to offer special terms to the oil companies, which have agreed to shoulder all exploration risks specified in the contracts. Nevertheless, disappointing results have forced China to ease its terms.

Already, improved terms are being offered to oil companies bidding in the second round.

Under the new round, China will waive a 12.5 percent royalty on marginal fields producing less than 1 million tons of oil a year.

The appraisal trial development program which is being conducted jointly by Total and China in the Beibu Gulf is another example of Beijing giving in to foreign companies.

Under the original contract, production should be a long-term exercise lasting for more than 10 years.

But because of the marginal prospects of Total's find, China has agreed on a trial program which will last for 2 years.

A long-term development will be embarked on if encouraging results emerge from the trial.

The Beibu field is scheduled to produce oil by the middle of next year and a review will be carried out in 1988. The total field is expected to produce about 700,000 tons of crude a year.

OIL AND GAS

PROFITABLE OFFSHORE FOREIGN DEALS POINT TO MORE FLEXIBLE POLICIES

OW261200 Beijing XINHUA in English 1115 GMT 26 Dec 85

[Text] Beijing, 26 Dec (XINHUA)--Great achievements have been scored in China's offshore oil industry since 1979 when China began to seek foreign help in exploring and developing offshore petroleum, Qin Wencai, president of the China National Offshore Oil Corporation (CNOOC) said here today.

To date, China has signed 28 oil contracts with 39 firms from 12 countries and 23 are being carried out, he said.

By the end of last November, a total of 110 exploratory wells had been sunk offshore and 41 had reported oil-gas flows, of which six yielded more than 1,000 tons daily.

This rate of success is regarded as high by international standards, Qin Wencai said.

This year, Sino-foreign cooperation in offshore oil development entered a new stage of exploration and production at the same time, he added.

Of the 83 structures explored, 23 have reported oil-gas discoveries. One is being developed and is expected to go into production in the latter half of next year. Decisions have been made to develop two more structures. Another six are undergoing feasibility studies.

The Chengbei oil field in the Bohai Sea, a Sino-Japanese joint undertaking, went on stream last October.

Moreover, there will be one new oil-gas field going into operation every year from 1986 to 1990, Qin disclosed.

For the first round of bidding for China's offshore oil which started in February 1982, China designated a total of 150,000 sq km for foreign oil firms to make their bids.

The first round has already ended and 19 contracts covering a total area of more than 90,000 sq km have been signed.

The second round began in November 1984. CNOOC has so far received offers from 24 foreign firms and four contracts were signed.

So far, four contracts have been signed and another six or seven contracts are expected to be signed for the second round, the president said.

By the end of November, he said, CNOOC's foreign partners had invested U.S. \$1.7 billion in China's offshore oil projects and this year's foreign investment is expected to surpass U.S. \$500 million.

In the past 6 years, China's offshore oil industry has developed quickly, Qin said. Now CNOOC boasts 10 drilling vessels, over 40 supply vessels, a number of platform-building and marine construction companies have also been set up.

At the same time, China has established 13 joint and more than 20 cooperative companies with foreign firms. Four consortia composed solely of Chinese firms have also been inaugurated.

Over the past 6 years, these companies have earned more than U.S. \$800 million by providing services.

Qin said that geological surveys and exploration conducted so far prove that there are bright prospects for oil development offshore China.

Inviting foreign businesses to join in China's offshore oil undertakings is the country's firm policy, Qin said. China will adopt more flexible policy measures on the basis of equality and mutual benefit and hopes to find more oil-gas fields through effective cooperation with foreign oil firms.

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CSO: 4010/25

OIL AND GAS

DAQING'S EFFORTS DURING SIXTH FIVE-YEAR PLAN RECAPPED

Harbin HEILONGJIANG RIBAO in Chinese 1 Oct 85 p 1

[Article: "Pleasing Results at the Daqing Oil Field During the Sixth Five-Year Plan--Crude Oil Output Continues To Be Stable, New Oil Resources Have Been Located"]

[Text] The production situation was excellent at China's largest petroleum production base area, the Daqing oil field, during the Sixth Five-Year Plan and the results were encouraging.

Daqing already has entered the high-water content development stage. The water content of the oil from its wells has been rising, as has the natural reduction rate. Even under such unfavorable conditions, crude oil output during the Sixth Five-Year Plan continued to exceed 50 million tons during the first 4 years and the excess will be even greater in 1985.

The amount of engineering completed during the Sixth Five-Year Plan at Daqing was 1.6 times the total amount completed during the first 21 years there. More than 6,000 wells were drilled during this period and the new wells produced 41 million tons of oil, 7.46 million tons higher than planned. Oil lifting equipment was installed at 2,473 well, which raised the average daily increase in output per well by 10 tons. Pressure fracturing also was carried out in more than 3,700 wells, which increased crude oil output by more than 500 tons. During this period, the rate of increase in the water content of underground oil pools was 2.3 percent in 1980 and was held to 0.66 percent in 1984. The comprehensive rate of decrease for the oil field has been controlled from the figure of 5.5 percent in 1982 to 1.8 percent in 1984.

Increased exploration work at Daqing during the Sixth Five-Year Plan was used to find new petroleum sources. During the first 4 years, they did 30,000 kilometers of seismic measurement lines and drilled 492 exploratory wells a total of 780,000 meters in length. This was three times the amount during the Fifth Five-Year Plan. They found 424 square kilometers in new oil-bearing areas and added new geological petroleum reserves of 180 million tons. There also was a substantial increase in natural gas reserves.

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CSO: 4013/24

OIL AND GAS

NEW TECHNIQUES BOOST DAQING OUTPUT

OW291810 Beijing XINHUA in English 1642 GMT 29 Nov 85

[Text] Harbin, 29 Nov (XINHUA)--A new technique has helped China's largest oil field increase output, despite fears of a decrease in oil production there, according to an expert here today.

The Daqing oil field in Heilongjiang Province, which accounts for over half of the country's annual crude output, began production in 1960.

Flooding started to severely affect the oil field in 1980 and its annual oil output was once expected to decrease from 350 million barrels in 1980 to about 220 million bbls in 5 years, a decrease of 37 percent.

The new technique--development technology in the high water-cut stage--has helped the oil field increase its annual output to 385 million bbls this year.

The technique involves 67 research projects, including the adjustment of the layout of oil wells.

The expert estimated that the application of the technique has resulted in extra profits of more than 1.3 billion yuan.

He emphasized that the significance of the technique's thorough application in Daqing is equal to that of the discovery of a new large oil field.

He pointed out that the new technique will also be of significance for China's other oil fields which have geological structures similar to that of Daqing.

Experiments on the new technique started in 1983 and were conducted by more than 300 scientists and engineers, the expert added.

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CSO: 4010/16

OIL AND GAS

SHENGLI PRODUCTION SAID 'READY TO TAKE OFF'

OW130343 Beijing XINHUA Domestic Service in Chinese 0118 GMT 12 Dec 85

[Article by reporters Zhang Suiwen and Song Xiwen]

[Excerpts] Jinan, 12 Dec (XINHUA)--"Throw all our energy into the task, we are confident that 'Shengli' will triumph." This slogan, which can be seen everywhere across the Shengli oil field, is inspiring its 130,000 staff members and workers to work extraordinarily hard to build Shengli into another Daqing oil field. Last year, its above-quota output of crude accounted for half of the nation's total above-quota production, and this year it has again ranked first in the nation's above-quota crude output in the first 11 months. Shengli's rapid development has fully demonstrated its ability to build itself into another Daqing oil field by the 40th national anniversary as originally scheduled.

Despite the cold wind at the end of the year, the ardor for work and action in Shengli oil field, which stretches across the entire Huang He delta, makes one forget that winter is already upon us. Discarding the conventional notion that "winter drilling is hard," the drilling company's more than 130 rigs roar day and night. Doing away with the habitual practice of winter training, the 27 teams of seismologists from the seismological headquarters have all insisted on working in the field. On the oil field's vast expanse of some 26,000 square km, throngs of workers are working hard in five new exploration sites. In the Gudong areas near the mouth of the Huang He, dikes and dams are fast rising one after another, enclosing a large oil field with a proven reserve of over 300 million metric tons, the largest discovered in China during the past 10 years.

Since the building of Daqing oil field in the 1960's, another major event in China's history of petroleum industry is the current task of building Shengli into another Daqing. The victory of the Daqing campaign put an end to China's reliance on "foreign oil," and the completion of a second Daqing would ensure an ample energy supply for the task of quadrupling China's total industrial and agricultural output by the end of the century. After 20 years of development and construction, Shengli has become China's second major oil field. During his inspection of Shengli in February last year, Comrade Hu Yaobang proposed a call for "building up a second Daqing to greet the 40th founding anniversary of our nation." Zhao Ziyang, Peng

Zhen, Wan Li, and other party and state leaders also visited Shengli and gave important instructions.

The expectations of the central organ leaders as well as the needs of the four modernizations have inspired all staff members and workers of Shengli. In building Shengli into another Daqing, the specific goals call for raising the annual crude output to 40 million metric tons by 1988 and bringing the annual production capacity to 50 million metric tons by 1990. To reach these goals, Shengli's workers must accomplish more work in 6 years than was completed in 20 previous years; and its annual average output has to be raised by 4 million metric tons each year. Faced with this arduous yet honorable task, the campaign headquarters has proposed a slogan: "Throw all our energy into the task, we are confident that 'Shengli' will triumph." The slogan reflects the aspirations of all Shengli's staff members and workers. They have translated the slogan into concrete deeds and action across the entire oil field.

Setting a goal of building itself into another Daqing oil field, Shengli is now spreading its wings and ready to take off. In less than 2 years it has found a total of proven reserves that nearly equal those found in the entire 20 previous years. Meanwhile, following the rapid discovery of new reserves, its crude output has also increased by large margins. Last year, it produced 23.01 million metric tons of crude, increasing 4.46 million metric tons over 1984; and in the first 11 months this year, it produced 24.76 million metric tons of crude, increasing 4.06 million tons over the same period of 1984.

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CSO: 4013/44

OIL AND GAS

PROSPECTS FOR SOUTH CHINA SEA OPERATIONS LOOKING UP

HK291442 Quangzhou Guangdong Provincial Service in Mandarin 0400 GMT 27 Nov 85

[Text] (Chen Tongtai), general manager of the East Nanhai Petroleum Company, told reporters a few days ago that prospecting and exploitation by the East Nanhai Petroleum Company had entered a new stage of simultaneously finding oil and appraising and exploiting a discovered oil field.

Since this company signed the first contract with five British companies, including B.P. Company Limited, in May 1983, at the first round of inviting tenders for offshore petroleum, it has signed 8 contracts with 7 groups organized by 22 companies from 8 countries, including Britain, Japan, the U.S., Canada, and Australia for cooperatively prospecting and exploiting the Nanhai petroleum resources. The total area of the contract zones is 16,895 square kilometers. At present, the drilling and sinking of 25 wells has been started. Four structures have been discovered and there are six producing wells. Oil or gas shows up in eight wells. On average, one of every eight exploratory wells is a producing well. The rate of success is relatively high for sinking offshore exploratory wells in the world.

Except for the first well, which produces slightly less oil, the daily output of the other wells has increased from 490 cubic meters to 2,345 cubic meters. The oil layer of a later well is thicker than that of an earlier one, output of a later well higher than that of an earlier one, the quality of oil of a later well better than that of an earlier one, and the reserves of the oil structure of a later well larger than that of an earlier one.

/7358

CSO: 4013/32

3 February 1986

OIL AND GAS

PREPARATIONS UNDER WAY FOR HAINAN OFFSHORE GAS DRILLING

HK060435 Hong Kong SOUTH CHINA MORNING POST (BUSINESS NEWS SUPPLEMENT) in English 6 Dec 85 p 8

[By Olivia Sin recently in Guangzhou]

[Text] China is making intensive preparations for the production of gas from a big offshore gas field south of Hainan Island.

A steering group comprising senior Chinese officials has been set up in Guangdong to study the market potential of the gas in the province.

Drilling will begin soon at two appraisal wells in the Yacheng gas field to further evaluate its reserves.

This follows the signing of the U.S.\$500 million joint gas development contract between the China National Offshore Oil Corporation (CNOOC) and two foreign companies 2 months ago.

China has signed agreements to buy all the gas from the field with foreign exchange in a bid to relieve the chronic energy shortage in Guangdong.

The deal is likely to place a substantial financial burden on China, which is expected to sell the gas for local currency.

But CNOOC sources defended the move, saying a steady gas supply will help thousands of factories and households and conserve other energy sources like oil and coal.

They said the State Council has agreed to allocate part of its foreign exchange reserves to support the mammoth project.

Pumping is scheduled to start on 1 July 1989, with annual production expected to reach 3.25 billion cubic metres 3 years later.

Sources close to CNOOC said in view of the tight timetable, upstream and downstream activities will have to be planned simultaneously.

The gas field, with initial estimated reserves of 90 billion cubic meters, is being jointly developed by CNOOC, the Atlantic Richfield Company and Santa Fe Minerals.

CNOOC will put up 51 percent of the \$500 million, Arco 34 percent and Santa Fe the remaining 15 percent.

CNOOC sources said China can suspend or postpone the purchase of the gas if the field's proven reserves are found to be less than the original estimate.

Nevertheless, the possibility of it turning out to be a smaller field are remote.

In fact, China is expecting bigger reserves of around 100 billion cubic meters.

The appraisal drilling is scheduled to be completed by April and a detailed development proposal is expected to be submitted to the Petroleum Ministry by July.

The gas produced will be purchased by a CNOOC subsidiary, the Offshore Natural Gas Utilisation Co, which has an office in Guangzhou.

The company will also be responsible for laying a 1,000-km pipeline from Hainan to Guangzhou and Shenzhen through the Leizhou peninsula.

To make sure there is a ready market in the province, the Guangdong steering group is going full steam ahead with its market survey and hopes to complete it by the end of next month.

The group comprises the vice-governor of Guangdong, Mr Guang Ji, the president of the Offshore Natural Gas Co, Mr Tang Zhenhua, senior officials from the Planning Commission, and the Petrochemical Bureau of Guangdong.

CNOOC sources said stationing Mr Tang, a young technocrat, in Guangzhou will be helpful in coordinating the huge program with various Guangdong authorities.

Although delays in China are not uncommon, officials are anxious to bring the project on stream as scheduled because the gas purchase contract stipulates China has to "take or pay" for the gas once it is produced.

This means at least part of the pipeline will have to be ready by July 1989, when production begins.

Mr Tang, also a vice-president of CNOOC, declined to comment on the project's progress in Guangzhou last week when he attended the opening ceremony of the Offshore China '85 exhibition, organised by the Wah Chang International Co.

It is understood the decision to develop the gas field was made after more than a year of tough bargaining.

Since Arco and Santa Fe refused to invest in downstream activities, estimated to cost more than U.S.\$500 million, China has to find ready use of the gas when it starts gushing.

The question of how to earn enough foreign exchange to recover the upstream and downstream investments is troubling Chinese officials.

Hong Kong is the best market to earn foreign exchange but it can only be reached through a long pipeline.

A proposal to build a fertilizer plant on Hainan Island to use the gas was rejected because its end products would not suit China's needs.

Chinese officials believe they will be able to break even on the overall gas project.

One source said CNOOC can use its share of the profit from the gas project to build the pipeline to Hong Kong.

Chinese officials are understood to be studying various channels to raise cheap funds for the development program.

Little is known about the pricing of the gas.

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CSO: 4010/25

OIL AND GAS

OFFSHORE OIL-GAS FIELD DISCOVERED IN LIAONING

SK140655 Shenyang Liaoning Provincial Service in Mandarin 1030 GMT 13 Dec 85

[Text] An oil and gas field has been discovered offshore near Huludao in Liaoning. Since last April the State Petroleum Prospecting Bureau and the Bohai Oil Well Drilling Company have conducted detailed surveys in the sea area near Huludao. Among the five oil wells which have already been drilled, three are good-quality oil and gas wells. Two of the three wells can each produce more than 1,000 tons of petroleum per day, and the other is a high-pressure natural gas well. The sea around this oil field is 21 meters deep, and the rock stratum is 2,500 to 3,000 meters thick. Being a close and epicontinental maritime oil field, it is similar to the Liaohe oil field in terms of geological structure.

Recently the State Council adopted a decision that this oil field will be surveyed and exploited by our country independently. Next year the State Petroleum Prospecting Bureau will concentrate its efforts on conducting a comprehensive survey in order to verify the total deposits of the entire oil field.

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CSO: 4013/44

OIL AND GAS

PETROLEUM MINISTER URGES MORE PROSPECTING AT ZHONGYUAN

HK230249 Zhengzhou Henan Provincial Service in Mandarin 2300 GMT 22 Dec 85

[Text] Minister of Petroleum Wang Tao pointed out after a recent inspection of the Zhongyuan oil field that it should give priority to prospecting work and strive to verify more oil and natural gas reserves, so as to become a major national oil field during the Eighth Five-Year Plan, producing more crude oil.

Wang Tao said: The Zhongyuan oil field has rich oil and gas resources and its geological conditions are excellent. The outlook for prospecting is encouraging. You are now in the initial period of prospecting and development. You should not be in too much of a hurry to produce more crude oil; instead, you should focus on prospecting. This oilfield should fight a prospecting campaign during the Seventh Five-Year Plan. Horizontally, prospecting should be extended into the still more extensive basin surrounding it; vertically, drilling should be carried out at depths of more than 7,000 meters. You should find more high-quality reserves. Only after verifying more oil and natural gas reserves can the oil field become a major oil field with relatively high output during the Eighth Five-Year Plan.

The Zhongyuan oil field is now drawing up its strategic principles afresh, so as to be able to shoulder the heavy task of being a major national oil field during the Eighth Five-Year Plan.

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CSO: 4013/44

OIL AND GAS

PETROCHEMICAL CORPORATION TO BOOST OUTPUT

OW071242 Beijing XINHUA in English 1131 GMT 7 Dec 85

[Text] Beijing, 7 Dec (XINHUA)--Output of the China Petrochemical Corporation will be worth 31.2 billion yuan next year, 1.2 billion more than this year, its president, Chen Jinhua, said here today.

The corporation will refine 589,610,000 barrels of crude oil next year, 3,780,000 barrels more than this year, he told a current meeting of corporation directors and managers.

Chen said that through technical improvements and more rational use of crude oil next year, the corporation was expecting to achieve the 1.2 billion yuan.

Greater efforts will be made to quicken the construction of major and backbone projects and complete the technical upgrading schemes of 27 projects in the coming year. These projects include the first-phase construction of three ethylene plants each with an annual production capacity of 300,000 tons, which are to be completed by the end of 1987, and the Ningxia chemical plant with an annual production capacity of 300,000 tons of synthetic ammonia in northwest China.

These schemes would help reduce energy consumption, and improve the quality and increase the quantity of oil products, including aviation gasoline, high-grade lubricating oils, paraffin, bitumen, chemical fibers, synthetic rubber and plastics.

Chen said measures would also be taken to raise the production capability to the designed level of the 43 imported ranges of equipment for chemical fibers, fertilizers and other petrochemical products.

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CSO: 4010/21

OIL AND GAS

MORE BEIJING HOUSEHOLDS GETTING NATURAL GAS

OW242029 Beijing XINHUA in English 1835 GMT 24 Dec 85

[Text] Beijing, 24 Dec (XINHUA)--The Beijing Gas Company has installed piped gas for more than 60,700 families this year, a company official said today.

The number of kitchens connected to gas mains now exceeds a quarter of a million, while another 726,000 families use liquefied methane gas cylinders.

The number of homes using coal briquets for cooking has been reduced to about 450,000.

The gas company's target over the next 5 years is to enable families in the city and near suburbs to use gas or other clean fuels for cooking, and to discard dirty and inconvenient coal stoves.

A shortage of liquefied methane gas has forced the company to control the increase in demand, said the official. It will now concentrate on supplying more piped gas.

Piped gas is usually supplied to residents of the rapidly-growing number of new apartment blocks. This enables them to transfer their gas cylinders to families living in older, one-story homes.

The cost of installing gas mains is usually met by workplaces, which build new apartment blocks.

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CSO: 4010/25

OIL AND GAS

CHARACTERISTICS OF DEHYDRATING CURVE OF SONGLIAO CLAY MINERALS AND THEIR ROLE IN OIL EXPLORATION

Beijing SHIYOU KANTAN YU KAIFA [PETROLEUM EXPLORATION AND DEVELOPMENT] in Chinese Vol 12, No 2, 1985, pp 11-16

[Article by Wang Xingxin [3769 5887 0207]: "The Dehydration Curve of Clay Minerals in the Songliao Basin and Their Significance in Oil Exploration"]

[Text] Increased burial depths and temperatures cause the conversion of smectite [also called montmorillonite] into illite and also separates out a great deal of interlayer water. The particles of clay minerals shrink in volume at this time while the porosity of the rock increases and intense changes occur in the characteristics of the intergranular pores and in the pore water. Because this period was the most important period for petroleum formation and migration in the basin, the dehydration reaction of the smectite had major effects on the migration and distribution of oil and gas in the basin. This article will attempt to examine the relationship between the characteristics of the dehydration curve of the clay minerals in Cretaceous mudstone in the Songliao Basin and the distribution and depth of oil and gas within the basin to discuss the significance of the dehydration curve of clay minerals in oil exploration.

I. Characteristics of the Dehydration Curve of Clay Minerals in the Songliao Basin

Clay minerals must release their intergranular water and interlayer water gradually during the lithification process. The dehydration curve of clay minerals is used to illustrate the vertical changes in their dehydration speeds. Figure 1 shows the dehydration curves of several clay minerals commonly mentioned in articles. Powers (1967) did not provide the data related to the dehydration curves he derived. Their tendency toward vertical changes in dehydration speed are not the same as actual data reported in Chinese and foreign reports. The dehydration curve of Burst (1969) is a revision of Powers' dehydration curve. The dehydration curve of Perry and Hower (1972) is based on depth intervals of 250 inches and studies the percentage reduction of smectite strata in mixed smectite-illite strata as a unit of dehydration speed to show the relationship between the dehydration speed of smectite and depth of burial. Their dehydration curve indicates that smectite undergoes two periods of rapid conversion and release of interlayer water during the process of conversion. The first instance (segment II in the diagram) involves the conversion

of smectite into nonsequential mixed smectite-illite strata. The second instance (segment III in the diagram) involves a conversion from non-sequentially mixed strata of smectite-illite to sequentially mixed strata of smectite-illite. After undergoing these two instances of rapid dehydration, smectite accounts for 20 percent of the mixed smectite-illite strata and their conversion is extremely slow.

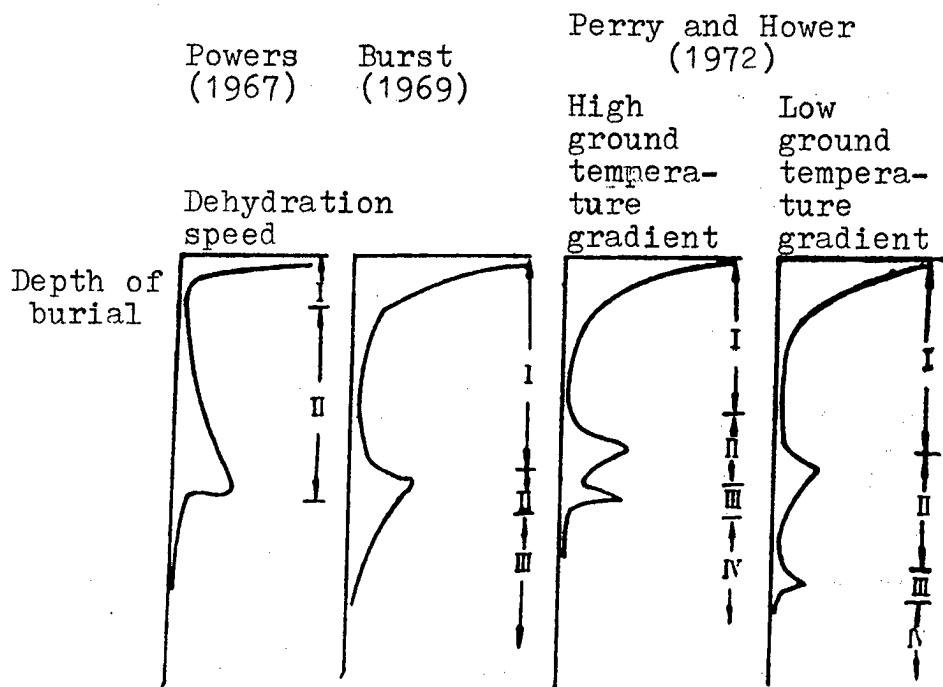


Figure 1. Dehydration Curves of Clay Minerals

With substantial support from related departments, experts took fairly systematic cores from the Gu-12 and Xu-11 wells to study the characteristics of the conversion of smectite into illite and the dehydration reaction during the process of mudstone lithification in the Songliao Basin. Besides continuous coring in the main target strata of exploration, the strata positions began at a well depth of 1,000 meters and spaced cores were taken at regular intervals. The maximum depth of the samples was 2,667 meters at the Gu-12 well and 2,011 meters at the Xu-11 well. Systematic analysis of the rock core sample was done, including X-ray diffraction analysis of clay particles smaller than 2 μm in the mudstone to measure the components and content of the clay minerals and to analyze the vertical changes in the percentage of smectite in mixed strata of smectite-illite. Moreover, dehydration curves for clay minerals from the Gu-12 and Xu-11 wells were drawn using the percentage reduction in smectite at depth intervals of 50 meters as a unit of the speed of dehydration of the smectite (Figure 2). The portion under 1,000 meters in well depth was derived using the vertical changes in porosity of the mudstone. These two wells are located in locations of deep subsidence in the primary oil generating depressions in the Songliao Basin that have undergone long-term subsidence (the

Gulong depression and the Sanzhao depression), making them representative of the dehydration reaction of the clay minerals in the Songliao Basin. The diagrams show that the dehydration reaction of the clay minerals in the Songliao Basin has the following characteristics:

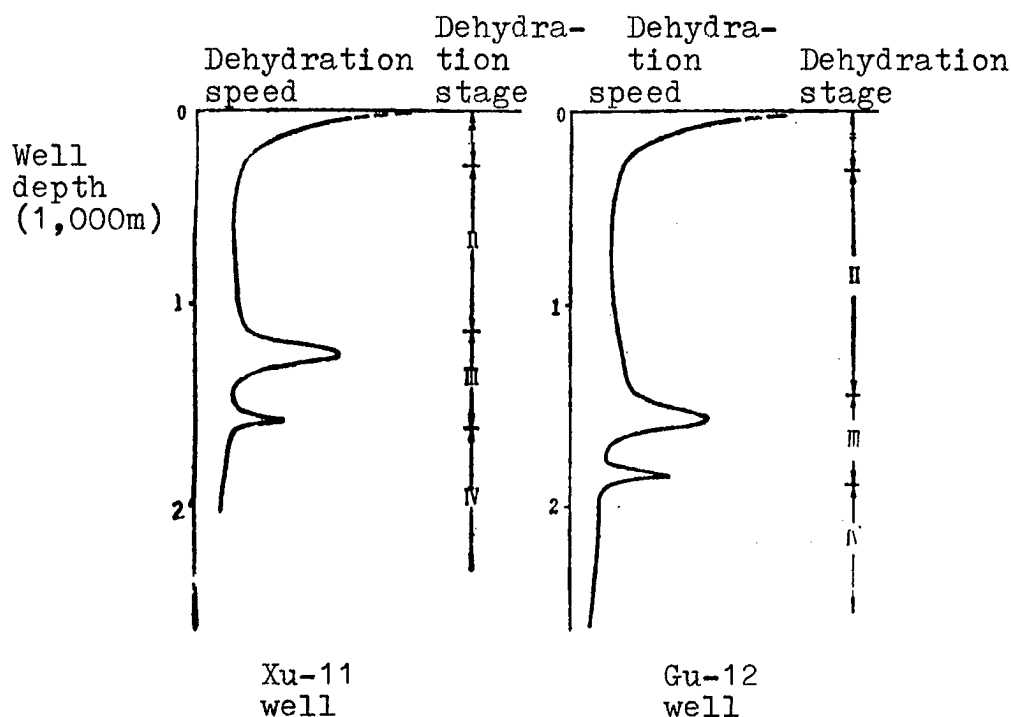


Figure 2. Dehydration Curves of Clay Minerals in the Songliao Basin

1. During the lithification process, the dehydration of the clay minerals undergoes the four following stages:

1) The stage of rapid pore water dehydration (I). During this stage, the pressure of the strata above causes the clay minerals to release rapidly the pore water between the particles of clay minerals and the excess interlayer water in strata of smectite (greater than the two aqueous strata).

2) The stage of interlayer water stabilization (II). After undergoing rapid dehydration and compression, the permeability of the argillaceous sediments becomes very low. Dehydration during this stage occurs through the slow release of pore water between the particles because of the capping pressure, while the interlayer water in the smectite remains stable throughout the process. If the interlayer water of two aqueous strata is maintained between the calcio-smectite strata throughout this stage, the maximum spacing between the bottom surfaces in the natural samples is within 14 to 15 Å.

3) The stage of rapid dehydration of interlayer water (III). During this stage, the increased depth of burial and temperatures causes the smectite to be converted into illite, and also causes the separation of large amounts of interlayer water. The particles in the clay minerals shrink in volume at this time,

resulting in pores and pore water. The capping pressure causes rapid release of the water and compression to occur again.

4) The period of slow dehydration at great depths of burial (IV). The mudstone is compressed once again following the rapid dehydration of the smectite and becomes denser. The release of the pore water between the particles of the clay minerals, the conversion of smectite into illite and the release of interlayer water proceeds extremely slowly at this time.

2. Stage III, which involves the rapid release of interlayer water, also can be divided into two periods of visibly rapid change that appear as two peaks in the figures. In the first instance, the dispersed smectite is converted rapidly into non-sequential mixed smectite-illite strata. This is the most important period because 60 to 70 percent of the smectite strata are converted to illite after the reaction and the interlayer water is released. Although dehydration during the second period proceeds more slowly than during the first, it also is quite apparent. This instance of dehydration caused the amount of smectite within the smectite-illite mixed strata to be reduced from the original 30 to 40 percent to around 20 percent. The conversion of this remaining 20 percent of smectite into illite proceeds extremely slowly during the process of deep burial. For this reason, only 80 percent of the smectite actually is converted into illite and releases its interlayer water during the dehydration process. The amount of dehydration is determined by the smectite in the mudstone. The amount of dehydration in the best oil generating rock in the Songliao Basin is about 20 percent of the volume of the oil generating rock and the amount of dehydration in regular oil generating rock is around 10 to 15 percent.

This characteristic not only is identical to the results of analysis in other areas of the Songliao Basin but also is extremely similar to the dehydration curve of Perry and Hower (1972). It shows that the conversion of smectite into illite and the dehydration reaction during the lithification process is a rapid reaction process of chemical thermodynamics that is controlled to a certain extent by temperature and pressure, and that it is not a continuous reaction process that proceeds slowly with increased depth of burial and temperatures.

3. The conversion of smectite into illite and the release of the interlayer water is extremely rapid. The perpendicular distance of the stage of rapid release of interlayer water is about 450 meters. This is identical to the characteristics of the dehydration curve for clay minerals in high temperature gradient regions derived by Perry and Hower (1972) and is a reflection of the characteristics of the high ground temperature fields in the Songliao Basin.

4. There are differences in the top boundaries of the depth at which the conversion of smectite into illite and dehydration occur in different parts of the basin. After structural restoration, however, the maximum depths all are between 1,200 and 1,500 meters and the ancient ground temperature is between 60° and 65° C, which is identical to the period of a great deal of oil generation and migration in the basin.

II. The Relationship Between the Dehydration of Clay Minerals and the Distribution and Depth of Petroliferous Strata

To clarify the relationship between clay mineral dehydration and the distribution of oil and gas within the basin, the author studied the relationship between the depth of petroliferous strata and the depth of each area during the stage of rapid release of interlayer water in clay minerals in 5,219 strata from 363 petroliferous exploratory wells and data wells in an area of 120,000 square kilometers in the northern part of the Songliao Basin. The depth of the top boundary of the stage of rapid release of interlayer water in each region is determined by the depth of conversion of smectite into smectite-illite. In regard to the depth of the lower boundary, however, the characteristics of the curve from the Gu-12 and Xu-11 wells (Figure 2) indicate that it can be determined by inferring downward 450 meters from the top boundary. The depth of the lower boundary that is inferred in this manner has been tested by areas with real analytical data and the results are extremely similar.

Figure 3 shows the relationship between the distributional depth of petroliferous strata in each part of the northern Songliao Basin and the depth of clay mineral dehydration. It can be seen in Figure 3 that:

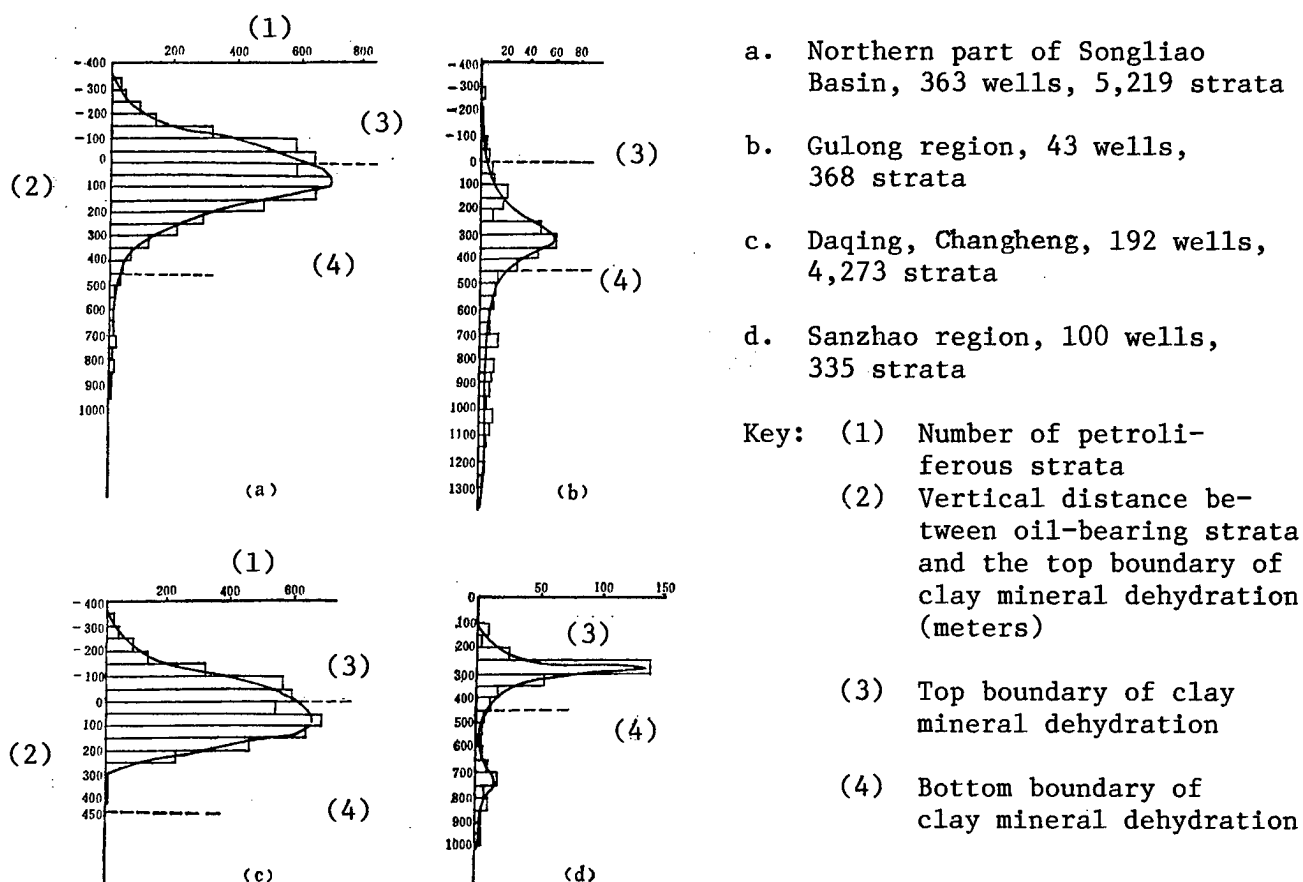


Figure 3. The Relationship Between the Distribution of Petroliferous Strata and the Depth of Clay Mineral Dehydration

1. The statistics on the 5,219 petroliferous strata in the northern part of the Songliao Basin show that only 185 strata are below the lower boundary of clay mineral dehydration at the present time, equal to only 3.5 percent of the total number of strata, while 96 are located in petroliferous strata above the lower boundary of clay mineral dehydration and 80 percent of the oil producing strata are located within 150 meters above and 200 meters below (a total of 350 meters) the vertical extent of rapid release of interlayer water (mixed smectite-illite strata).

2. At Changheng in the Daqing Oilfield, the maximum vertical distance of oil and gas migration upward from the top boundary of rapid release of interlayer water is within 400 meters, a height that is similar to the 385 meter height of oil bearing strata now found in the Saertu structure at Changheng in Daqing

3. The petroliferous strata in the Sanzhao depression are located below the depth of the top boundary of the zone of rapid release of interlayer water in present strata (1,200 meters). The two peaks in the frequency distribution of the depth of petroliferous strata indicate the characteristics of the distributional depth of the two primary oil reservoir strata in the Sanzhao depression, the Putaohua oil strata and the Fuyu oil strata. These characteristics are expressed as:

1) The Sanzhao depression has no large anticlinal structure like the one at Changheng at Daqing and the distribution of petroliferous strata is controlled mainly by the depth of burial of reservoir strata.

2) During the late period of the Nenjiang group and the late period of the Mingshui group after the oil and gas had entered the Fuyu oil strata and the Putaohua oil, this region still was in a process of uneven subsidence and sedimentation. This caused the depth of burial of petroliferous strata to move downward below the top boundary of the rapid release of interlayer water in clay minerals at the present time, and some of it is located below the present lower boundary. These characteristics confirm the results of exploration in the Sanzhao region.

4. The relationship between the depth distribution of the petroliferous strata in the Gulong region and the depth of clay mineral dehydration bears an overall similarity to that in the Sanzhao region. Most of the petroliferous strata are located below the top boundary of clay mineral dehydration, indicating that it has the characteristics of an oil generating depression that underwent a long period of continuous subsidence after the oil and gas had entered the reservoir strata. The differences from the Sanzhao depression are:

1) The Gulong depression has many oil strata and a great degree of subsidence during later periods. There are only two suites of petroliferous strata in the Sanzhao depression: the Fuyu oil strata and the Putaohua oil strata. The apex of the depth of the Putaohua oil strata is 200 to 250 meters below the upper boundary of clay mineral dehydration. The Gulong depression, however, has five suites of petroliferous strata systems, the Fuyu, Gaotaizi, Putaohua, Saertu and Heidimiao. The depth of the apex of the Saertu and Putaohua oil strata is located between 300 and 350 meters below the top boundary of the

dehydration curve of clay minerals and there was a greater degree of subsidence during later periods than in the Sanzhao depression.

2) In the Gulong depression, the effects of the Longhugou anticlinal structure have been to a reduced distribution of oil and gas above the top boundary of clay mineral dehydration.

3) The Fuyu oil strata in the Gulong depression did not develop in the same way as in the Sanzhao depression. There are great variations in the distributional depth of petroliferous strata and the added influences of the Gaotaizi oil strata have given no obvious apex position to the Fuyu oil strata.

III. Significance in Oil Exploration

1. They indicate the scope of the depth distribution of target strata for exploration

The period of conversion of smectite into illite and dehydration was the most important period of petroleum formation and migration in the basin. Underground fluids always migrate upwards. For this reason, the zone of mixed smectite-illite strata clays (sandy strata) and the strata just above are the most important strata locations for oil exploration in the basin, as was mentioned above. The depth range of its vertical distribution is related to the ground temperature gradient. The higher the ground temperature, the narrower the range of its vertical distribution. Furthermore, it also is related to the characteristics of oil and gas migration and the developmental history of structures.

2. It reflects the differences in the developmental histories of structures in different regions

Differences in the relationship between the depth of clay mineral dehydration in different regions of the basin reflect different developmental histories of their structures. This is especially true of the period after the oil and gas has entered the reservoir strata. This point is quite obvious at Changheng in Daqing, the Gulong depression and the Sanzhao depression.

Burst (1969) pointed out when describing the relationships in the distributional model of underground fluids and clay mineral dehydration in the coastal regions of the Gulf of Mexico that the fact that clay mineral dehydration already was extremely slow in deep strata below the lower boundary of clay mineral dehydration, while the mudstone underwent another period of rapid compression and the porosity also became smaller. This made it impossible for these strata to have industrial oil and gas pools. We feel that this sort of relationship is true only when changes in depth of burial are not apparent from the time that the petroliferous strata were formed up to the present. This may be applicable for certain Cenozoic sedimentary basins. Petroleum migration and accumulation in the Songliao Basin, however, occurred mainly during the Upper Cretaceous late Nenjiang group and late Mingshui group. The Gulong depression

and Sanzhao depression in the basin underwent sustained periods of sedimentation during the Tertiary, which created major differences between the current lower boundary of clay mineral dehydration and the depth of the lower boundary of clay mineral dehydration during the period of oil strata formation. Actual data for the basin also show that the area below the current depth of the lower boundary of clay mineral dehydration still should provide oil strata distributions for exploitation. The most prominent example is the Fuyu oil strata in the Sanzhao depression. This is a result of the fact that it continued to subside after the oil and gas had entered the petroliferous strata. For this reason, the author feels that application of the Burst model of the distribution of underground fluids should be done in conjunction with actual geological conditions. Attention should be paid to the differences in regional geological histories concerning the depth of clay mineral dehydration during a certain period (such as the oil strata formation period) and the depth of clay mineral dehydration at present, meaning that attention should be given to variations in the geological history of the depth of the lower boundary of clay mineral dehydration during the period of oil strata formation.

3. They reflect differences in the characteristics of oil and gas migration.

The relationship between the distributional depth of oil and gas and the different depths of the top boundary of clay mineral dehydration at Changheng in Daqing illustrates differences in the characteristics of oil and gas migration: At Changheng in Daqing, buoyancy caused the oil and gas that entered the reservoir from the depth of the oil generation window (the top boundary of clay mineral dehydration) to move upward along structures, the maximum distance being limited by the degree of structures and degree of interconnection of the sandstone. For this reason, most of the oil strata are located above the current depth of the top boundary of clay mineral dehydration. The lack of any substantial structural uplift in the Sanzhao depression subjected the distribution of oil and gas mainly to the burial depth of reservoir strata. We can see here that the extent of vertical migration of oil and gas in classic rock systems of interbedded sandstone and mudstone is controlled by the thickness of the individual oil generating rock strata and the degree of structures, meaning that the height of preliminary oil and gas migration within the oil generating rock is controlled by the thickness of the individual strata of oil generating rock. After the oil and gas has moved from the oil strata into the nearby reservoir strata, the height to which the oil and gas migrates along the reservoir strata is controlled by the degree of structures. If the oil and gas moves upward along a fracture zone, the distance of vertical migration is controlled by the height to which the fracture zone extends. Overall, oil and gas migration in the basin has the characteristics of lateral migration and the distribution of oil and gas within the basin mainly is controlled by the characteristics of vertical migration.

Comrades Xin Guoqiang [6580 0948 1730], Guo Guirong [6753 2710 2837] and Lu Zhifu [5684 1807 4395] also participated in this research project.

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12539/7051

CSO: 4013/136

OIL AND GAS

PRELIMINARY ANALYSIS OF OIL, GAS RESERVOIRS IN SHULU DEPRESSION

Beijing SHIYOU KANTAN YU KAIFA [PETROLEUM EXPLORATION AND DEVELOPMENT] in
Chinese Vol 12 No 3, 1985 pp 5-12

[Article by Liu Tiechuan [0491 6993 6898] and Jiang Hongtao [3068 1347 3447]
of the Geophysical Exploration Bureau, Ministry of Petroleum Industry: "A
Preliminary Exploration Into the Formation of Oil and Gas Reservoirs in the
Shulu Depression"]

[Text] Abstract

There is a certain continuity in the developmental history of the Shulu depression and it is extremely conducive to the formation of oil and gas pools. The authors explore the degree of maturity of oil generating rock buried at different times and under different temperature conditions, and they examine the period of the conversion of oil generating rock into hydrocarbons and the subsequent process of hydrocarbon discharge. The history of structural development is integrated with the mutually overlapping and matching relationships involved in hydrocarbon formation and discharge in oil generating rock to provide a further description of the process of oil and gas pool formation in the Shulu depression. Finally, the article outlines the characteristics of oil accumulation and integrates practice in drilling wells to select examples of oil formation and provide directions in the search for new oil and gas pools.

The Shulu depression is located in the southern part of the central Hebei depression and covers an area of about 740 square kilometers. A Cenozoic scoop-shaped fault subsidence developed on the pre-Tertiary basement and controlled the developmental history of early Tertiary structures and sediments. The Shulu depression covers a narrow area and already has seen the discovery of oil pools including the one at Jingqiu. It is rich in oil and gas resources. This article will discuss its petroleum geology characteristics, the accumulation of oil and gas and the formation of oil and gas pools.

I. Structural Characteristics and Developmental History

The Cenozoic "Himalayan orogeny" mainly involved block fault activity. This was especially true of the Eocene and Oligocene, which were the periods of most intense activity, and it is manifested as several normal faults with very large drops that caused the basement to fracture into many basic rock

fault block bodies. The relative differences in uplifting and subsidence activity of the various fault blocks led to the formation of a series of large fractures with an NNE orientation and thereby to the development of the structural layout of the Shulu depression during the early Tertiary. It has the characteristics of secondary structural components of two uplifts and three depressions moving from south to north (Figure 1).

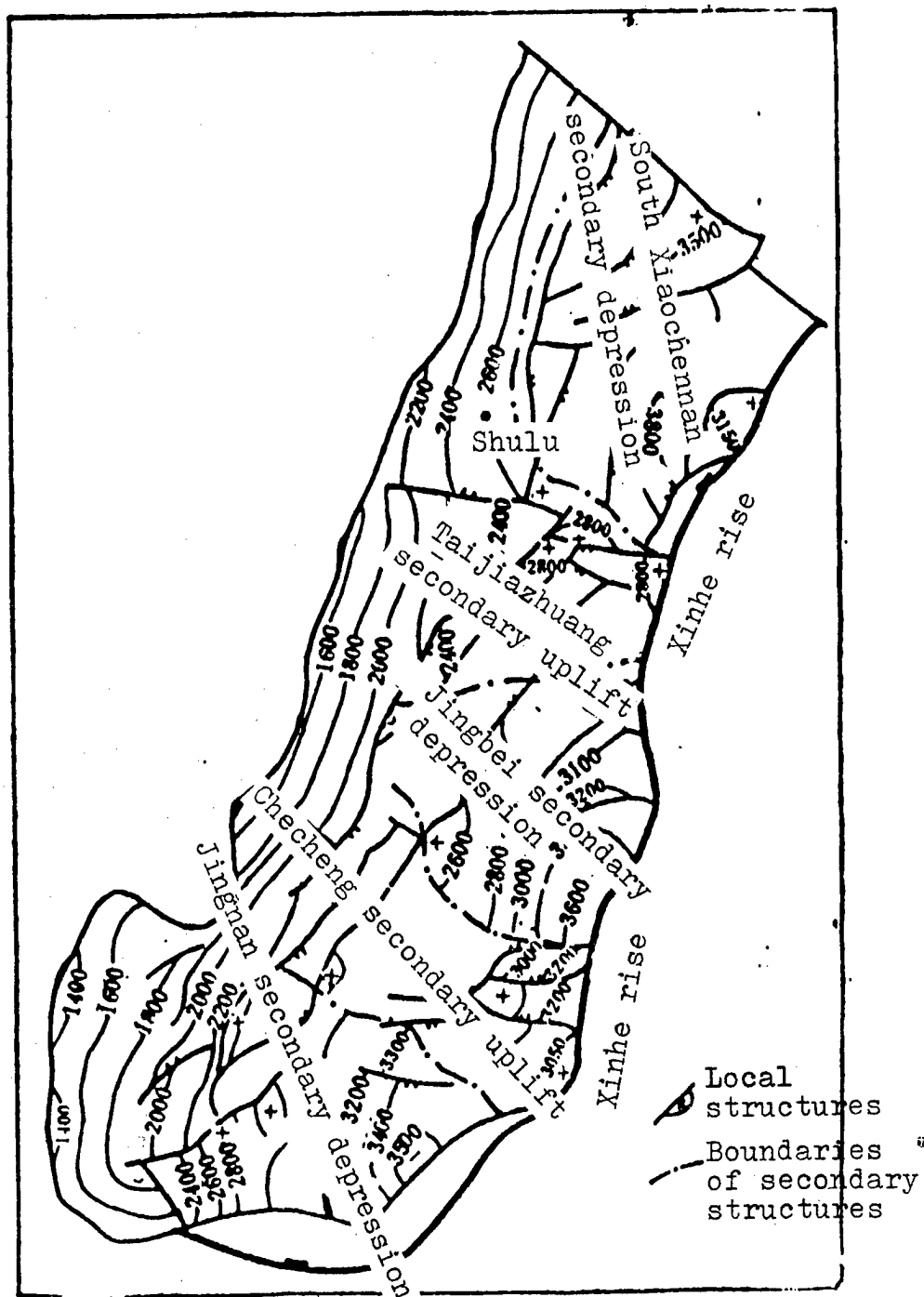


Figure 1. Structural Components of the Shulu Depression

The two uplifts are the Checheng and Taijiazhuang secondary uplifts, with either an NW or nearly east-west orientation. They were in a relatively high position through the Eocene and Oligocene periods, and the high point moved as time passed, gradually moving southward. The three depressions are the Jignan secondary depression, the Jingbei secondary depression and the south Xiaochennan secondary depression. These three depressions have sediments 5,200 meters, 5,400 meters, and 4,600 meters thick, respectively. They all lie along an NNE or nearly north-south distribution, and are steep in the east and gentle in the west, forming an asymmetrical distribution.

Several charts of ancient structures indicate that, during the last part of the Eocene Sha-4 member--Kongdian period, the Checheng secondary uplift was manifested as a nose uplift extending to the southwest from the Xinhe rise. The location of the Taijiazhuang secondary uplift in the modern structures is in a rather narrow saddle-shaped position. The formation of these two positive structures separated the Shulu depression during that time into three secondary depressions. Moving from south to north, they had respective areas of 20, 12, and 18 square kilometers and thicknesses ranging from 2,000 to 2,600 meters, 2,000 to 2,600 meters, and 1,000 to 2,200 meters. The south Xiaochennan secondary depression was the thinnest (Figure 2).

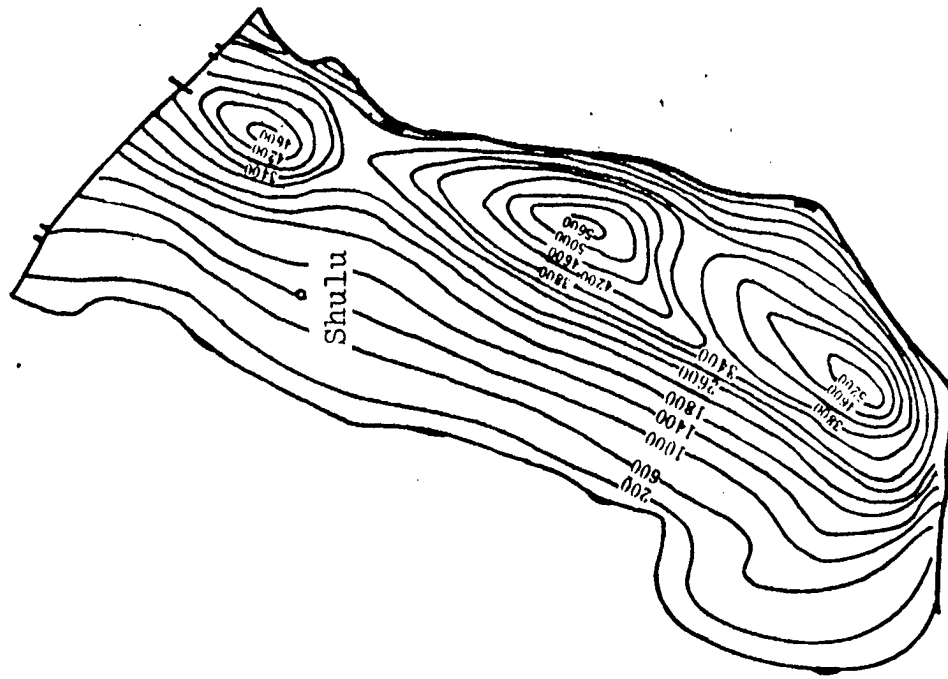
The Eocene paleostructural configuration basically was sustained into the early part of the Oligocene period (the Sha-2--late Sha-3 period). The three depressions expanded gradually on their original configurations, with areas of 35, 50, and 30 square kilometers, respectively, moving from south to north. Their thicknesses were, respectively, 3,000 to 4,000 meters, 3,000 to 4,600 meters, and 2,000 to 3,400 meters and they developed as secondary depressions on the southern and northern sides of Jingqiu.

The three secondary depressions expanded further during the late part of the Oligocene (Sha-1--late Dongying) to areas of 50, 50, and 45 square kilometers, respectively, and to thicknesses of 3,800 to 5,200 meters, 3,800 to 5,400 meters, and 3,000 to 4,600 meters. The regions of relative development remained the two secondary depressions to the south and north of Jingqiu.

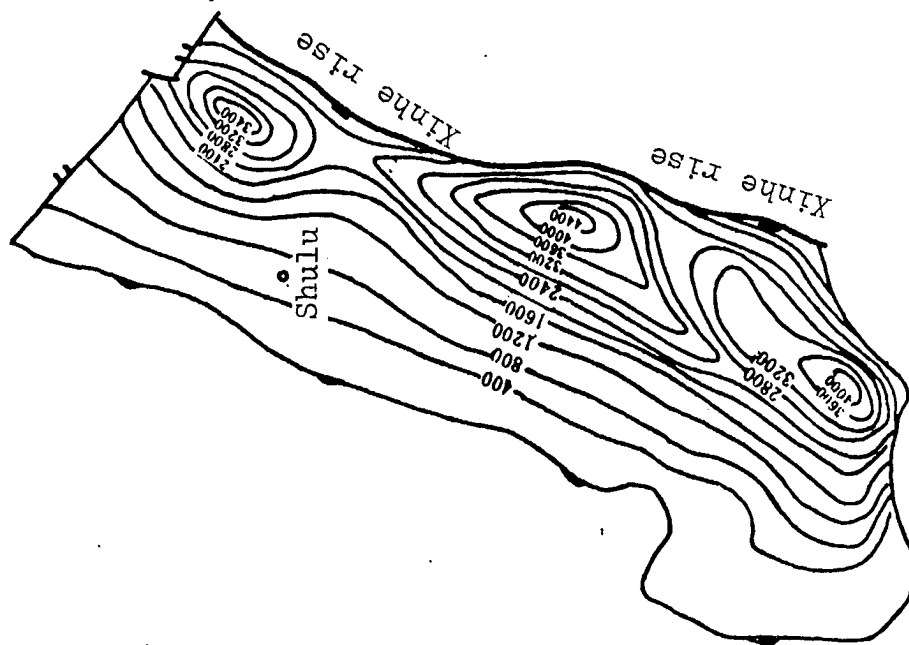
To summarize, the two uplifts and three depressions in the Shulu depression remained in existence from the Eocene to Oligocene periods and had a certain continuous quality. They were centers of subsidence as well as of sedimentation, and they were conducive to the formation and accumulation of oil and gas.

The paleostructural development profiles related to fracturing activity and its occurrence and development indicate that fracturing at the boundary of the Shulu depression began prior to the Eocene (Figure 3). The block fault activity of the extensional normal faults resulted in the continuous uplifting of the Xinhe rise and formed the large NNE-oriented Xinhe fracture. This fracture formed early and underwent frequent activity over a long period. The result was great differential drops in the basement fractures, reaching a maximum of more than 6,000 meters, that controlled the development of sediments in the Shulu depression.

End of Sha-1--
Dongying group
sediments



End of Sha-2
member sediments



End of Sha-4
member sediments

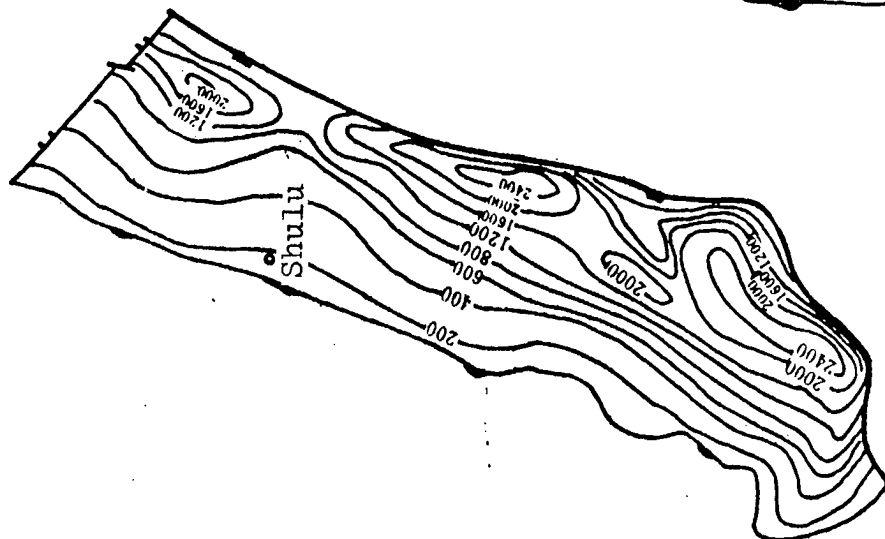


Figure 2. Paleostructural Development in the Shulu Depression

The formation period of the secondary fractures within the depression is easily discerned from paleostructural development profiles. Two normal and antithetic normal faults with an NNE orientation formed at the end of the Sha-1 member and divided the Shulu depression into three zones. The drop of these normal and antithetic faults gradually intensified after sedimentation at the end of the Dongying period. A chasm-like fault terrace holding antithetic and positive normal faults with an NNE orientation has been revealed on the slopes near the depression. The activity of this group of faults did not cease until the end of the Guantao period. The modern structural configuration of eastern and western structural zones had taken shape by the end of the Guantao period. The formational period of the faults with almost an east-west orientation within the depression generally was later than the faults with an NNE orientation, and they have a tendency to change from older to younger moving from north to south. This meant that the Shulu depression was affected by the activity of groups of faults with two different orientations and that there was a tendency toward increasing complexity.

II. Oil and Gas Accumulation and the Formation of Oil and Gas Pools

The question of oil and gas formation in the Shulu depression will be discussed mainly in terms of the geological background of oil formation. The article also will discuss the period of hydrocarbon discharge in oil generating strata and the question of subsequent oil and gas accumulation.

The evolution of the three secondary depressions indicates that they were in a stage of stable subsidence through their geological history, which is a favorable sedimentary condition for oil generation. Few exploratory wells have been drilled into strata of the Sha-4--Kongdian period. Analysis of seismic strata indicates noncontinuous weak amplitude seismic strata with poor continuity. Wells drilled in adjoining areas indicate that it is a large suite of dark mudstone that is a low-energy shallow lake facies accumulation. There was an obvious expansion of the lake basin's drainage basin during the Oligocene Sha-2 and Sha-3 member periods and no overlap phenomena appear in any of the reflections. They generally developed fairly continuous medium amplitude seismic facies (Figure 4). Wells indicate that the corresponding lithology is slightly argillaceous dark interbeds of sandstone and mudstone. These strata have good stability and extend rather far. This is especially true of the sedimentation center, where the sandstone facies change to shale, indicating that it was a long period of a stable subsidence environment, which is conducive to the deep burial and preservation of mudstone rich in organic matter.

The lower tertiary strata that already have been drilled into are rich in freshwater animals and terrigenous plant fossils. Examples include mussel-shrimp, brittlewort, and mixed plant fragments. They are an extremely rich mixture of organic matter, indicating that they are from a stage of flourishing life and that they provided the material foundation for the formation of oil and gas. Existing geochemical indices indicate that both the Sha-2--Sha-3 member and the Sha-1 member are rather good oil generating rock and that the mixed parent material already has reached maturity. This further illustrates that it has a certain oil generation capacity (Table 1).

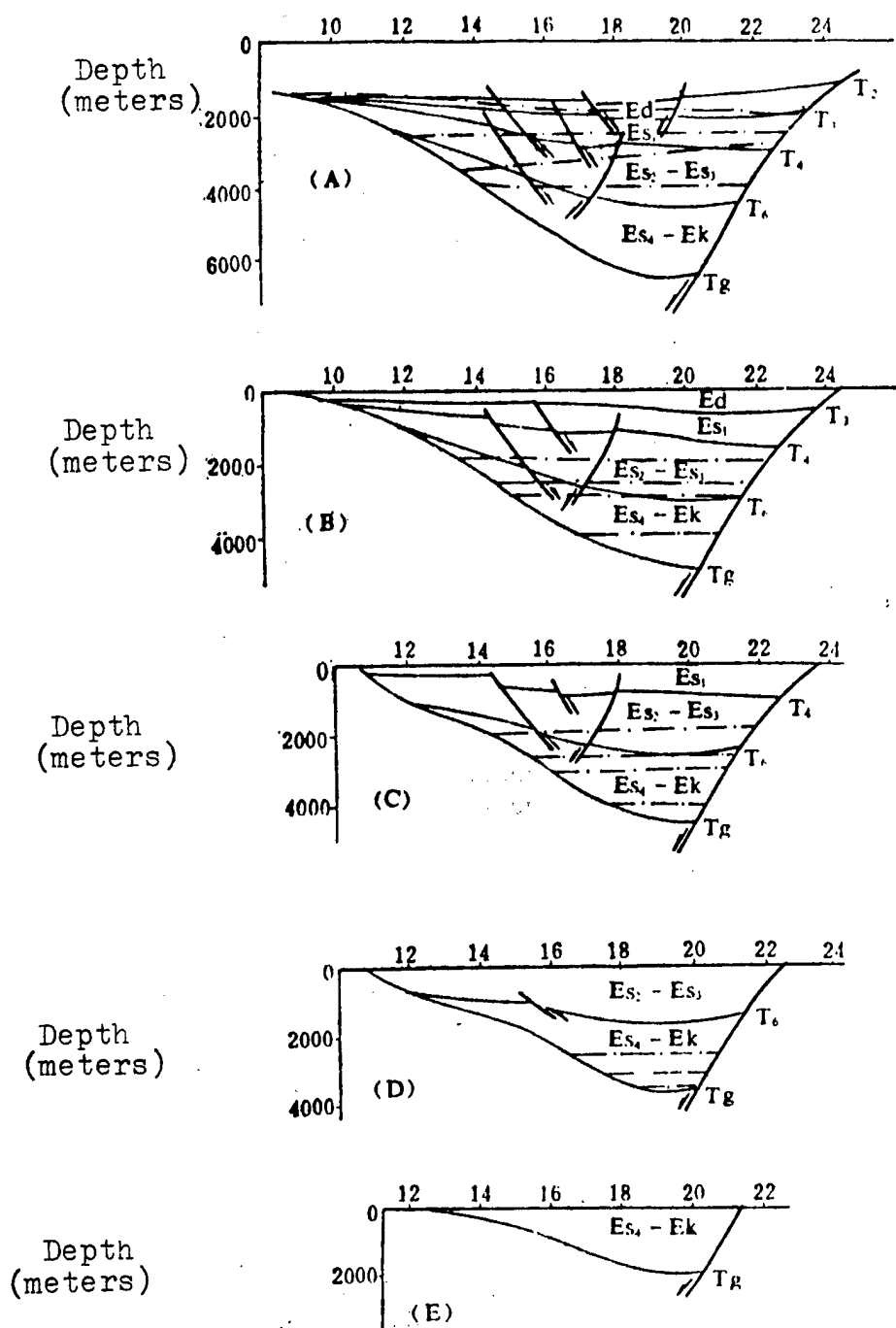


Figure 3. Paleostuctural Development Profiles in the Shulu Depression

Table 1. Geochemical Indices in the Shulu Depression

Index	Strata position: Sha-1 member	Sha-2,3 members		Source of data
	Numerical value: Average value	Average value		
S ⁼ (percent)	0.62 (8)	0.46	(28)	Jin-29 well
Organic carbon (percent)	0.61 (118)	0.44	(305)	Jin-8,28,29,45 wells
Chloroform bitumen "A" (percent)	0.115 (38)	0.1115	(111)	Jin-8,28,29,45 wells
Total hydrocarbons (ppm)	324.8 (15)	228	(30)	Jin-8,28,29,45 wells
Total hydrocarbons/organic carbon (percent)	5.067 (15)	4.45	(30)	Jin-8,28,29,45 wells
Saturated hydrocarbons/aromatic hydrocarbons/percent)	2.67 (2)	2.274	(11)	Jin-29 well
OEP	1.16 (7)	1.063	(18)	Jin-8,28,29,45 wells
Type of parent material	mixed	mixed		

Note: Figures in parentheses refer to the number of samples.

This depression has the material foundation for oil generation but it also requires the temperature conditions for pyrolytic hydrocarbon formation. As mentioned previously, the early Tertiary involved a long stage of stable subsidence, and it has excellent preservation conditions. As time passed, the strata were buried deeply and the ancient temperature gradient rose, creating the conditions for pyrolytic hydrocarbon formation from organic matter.

In order to determine the evolutionary situation in thermal maturation of oil generating strata within the region, we applied the TTI method calculated by the Marine Resources Evaluation Institute to estimate the time-temperature index TTI value. We made calculations for 28 points on 10 seismic measurement lines and derived a corresponding depth-pyrometamorphosis curve. Analysis of data on the depth of burial for each profile indicates that the range of depth for entering the oil generating window is 2,400 to 2,600 meters and that the depth limitation value for the oil generation portal in this region is 2,500 meters. Based on the above depth limitation value for the oil generation portal, we delineated the effective oil generating area of the lower Tertiary moving from older to newer, which means the Sha-4--Kongdian group, the Sha-2--Sha-2 segment and the Sha-1--Dongying group have areas of 35, 91, and 202 square kilometers, respectively, and an effective oil generation thickness of 450, 638, and 165 meters. This shows that the sustained stable subsidence and expansion of the lake water was followed by the development of oil generating depressions. The North China Oil Field and ourselves have calculated the amount of oil generated by the strata of each era, but the results are not very similar (see Table 2).

Table 2. Calculation of the Amount of Oil Generated

Item	Strata position				North China Oilfield (according to Liu Yuying [0491 3768 5391])
	Es ₁	Es ₂₊₃	Es ₄ + Ek		
Effective area of oil generating rock (square kilometers)	202	91	35	328	
Effective thickness of oil generating rock (meters)	164.8	637.7	450	1252.5	
Chloroform hydrocarbon "A" (percent)	0.115	0.1115	0.1112		
Migration coefficient (k) (percent)	35.1	35.1	35.1		
Amount of oil generated (Q _{total}) (100 million tons)	1.18	2.0	0.54	3.72	4.1
Amount of oil generated (Q _{residual}) (100 million tons)	0.88	1.48	0.4	2.76	2.48
Amount of oil generated (Q _{migrated}) (100 million tons)	0.3	0.52	0.14	0.96	0.726

In summary, the geological background of the Tertiary oil generating strata in the Shulu depression indicates that it not only could have accumulated rich amounts of organic matter, but moreover that burial and pyrolytic hydrocarbon formation happened immediately. Just as Comrade Liu Yuying [0491 3768 5391] described the oil generating strata in the Shulu depression as having such characteristics as high chloroform bitumen "A," a high peak carbon number, obvious odd-even advantages and so on, it is an oil generating stratum of low maturity (see Table 3).

The Sha-2--Kongdian group oil generating strata in the depression began to mature 24 million years ago, equivalent to the early part of the Guantao group. By 16.7 million years ago, which is equivalent to the middle part of the Guantao group, all of the oil generating strata had entered the stage of maturity. By 12.6 million years ago, however, which is equivalent to the late part of the Guantao group, it also had evolved to the overly-mature stage.

The oil generating rock of the Sha-2--Sha-3 member only began to enter the stage of maturity 16 million years ago (equivalent to the middle and late periods of the Guantao group). All of the oil generating rock in the Sha-2--Sha-3 member had reached the stage of overmaturity by 7 million years ago, equivalent to the early period of the Minghuazhen group.

Table 3. Geochemical Indices of Oil Generation in the Shulu Depression

Numerical indices	
C (percent)	0.557
A (percent)	0.1325
Conversion indices	
A/C (percent)	23.7
Hydrocarbons/C (percent)	8.8
Hydrocarbons/A (percent)	37.2
Normal paraffin	
Main peak carbon	C ₂₅
OEP	1.02
Isomer group components (percent)	
Pristane/Plant alkyl	0.46
Saturated hydrocarbons	32.29
Aromatic hydrocarbons	13.33
Nonhydrocarbons	49.6
Bituminous material	4.68
Saturated hydrocarbons plus aromatic hydrocarbons	45.62
Saturated hydrocarbons/aromatic hydrocarbons	2.42

The oil generating rock in the Sha-1 member began to mature 12.2 million years ago, equivalent to the late period of the Guantao group, and it gradually reached the overly mature period during the late period of the Minghuazhen group.

In summary, the organic casein base that accumulated in the oil generating rock during the maturation process was in the optimum period for conversion into hydrocarbons. The time before the oil generating rock had completely solidified into rock also was the optimum period for hydrocarbon discharge and oil accumulation. It is inferred from this that the hydrocarbon discharge was different for the three groups of oil generating rock. The period of hydrocarbon discharge from the Sha-4 member--Kongdian group oil generating rock should be the early to middle periods of the Guantao group. The period of hydrocarbon discharge from the Sha-2--Sha-3 member oil generating rock should be the middle period of the Guantao group to the early period of the Minghuazhen group. The period of hydrocarbon discharge from the Sha-1 member oil generating rock was somewhat longer, generally from the late Guantao period to the late Minghuazhen period. This type of evolutionary process generally occurred after the period of structural formation.

As mentioned above, the Shulu depression not only has excellent oil generating parent rock but also has the optimum periods of pyrolytic hydrocarbon formation and hydrocarbon discharge. During this period of evolution, the presence of oil and gas traps undoubtedly would have led to the formation of oil and gas pools. The two Jingqiu-Checheng and Mengguan-Taijiazhuang uplifts continually

were at rather high positions on the uplift. This is especially true of the late Sha-1 period, when the modern Jingqiu and Mengguan structural traps were formed gradually. After the addition of the Sha-1 member sediments, many faults within the depression continued to develop. Fracturing activity basically had come to an end by the late part of the Guantao group sediments. This period also was the late Sha-1 period to early Guantao period, and the Sha-2--Sha-3, Sha-4--Kongdian group and the Sha-1 member oil generating rock in the three secondary depressions were in their optimum hydrocarbon formation period, which was followed by the optimum hydrocarbon discharge period. The fact that the migration paths and faults of that period already had formed meant that the two Checheng and Taijiazhuang secondary uplifts were exactly in the direction of oil and gas migration. The two Jingqiu and Mengguan structural traps located in the secondary uplifts had a certain capacity for capturing oil and gas. The most recent well drilling experiments indicate that industrial oil flows or oil and gas indications developed in both of them.

III. Basic Characteristics of Oil and Gas Pools

An Eocene to Oligocene oil formation combination developed broadly on the pre-Tertiary foundation in the Shulu depression. Frequent block fault activity led to the formation of many types of traps and thereby to the formation of oil and gas pools. They include strata-controlled, buried hill-controlled, structurally entrapped and lithologically sheltered oil and gas pools, and there also are oil and gas pools sheltered by positive and negative normal faults and by unconformities. The Jingqiu oilfield is a structurally-entrapped oil and gas pool, and the other types of oil and gas pools now are in the inferential and predicted stage. The formational characteristics of oil and gas pools are summarized below.

1. Shore and shallow lake alluvial gravel shoal strata are facies zones conducive to oil and gas accumulation. Seismic stratigraphic analysis indicates that five "draped seismic facies" of different shapes and sizes developed in the shallow shore and lake facies zones in the western part of the depression during the early Oligocene Sha-2 to Sha-3 member sedimentation period. Wells have revealed that it is a suite of conglomerate and sandstone interbedded with mudstone strata, and some seismic profiles indicate that it lies oblique to underlying strata. The internal structure of its reflection wave groups reveal alternating strong and weak reflection waves that are an indication of alternating conglomerate, sandstone, and mudstone, so it should be an excellent reservoir body. Because this type of "seismic facies" wedges deeply into the shore and shallow lake facies zones, the "draped facies" reservoir bodies lie very close to the oil generating depressions, thereby creating a favorable reservoir body near the oil source and with short migration distances, which is extremely favorable for the formation of oil and gas pools.

2. Broadly distributed sheet sand bodies within the alternating fluviolacustrine facies zones are the direction of oil and gas. Alternating fluviolacustrine facies sediments often developed within the broad basin in the Jingqiu secondary depression during the late part of the Oligocene Sha-2 and Sha-3 member. The fact that water flow alternations were rather frequent at that time means that there is alternating mud and sand. All of the seismic profiles

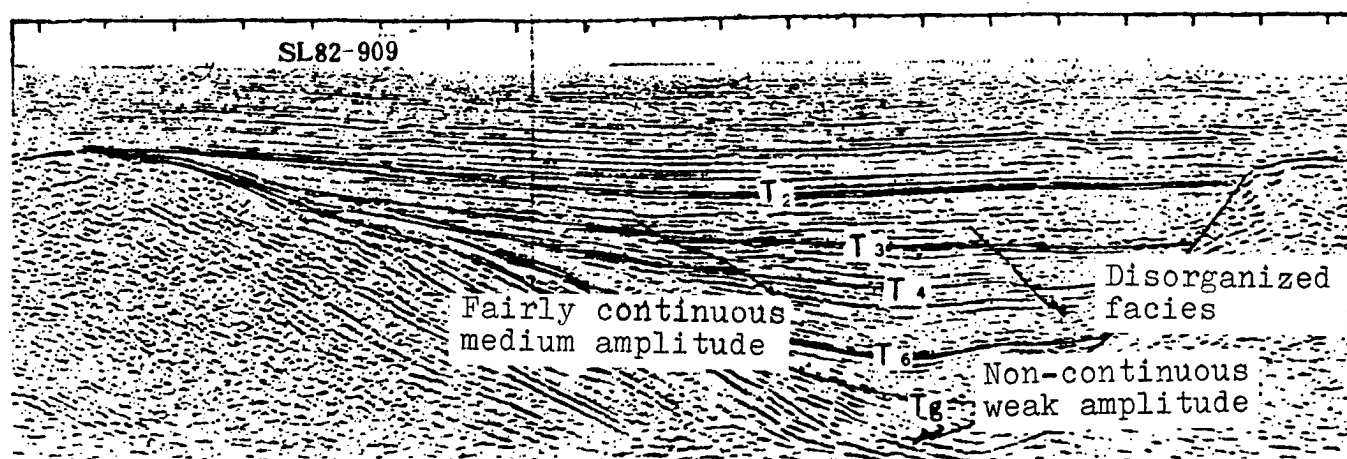


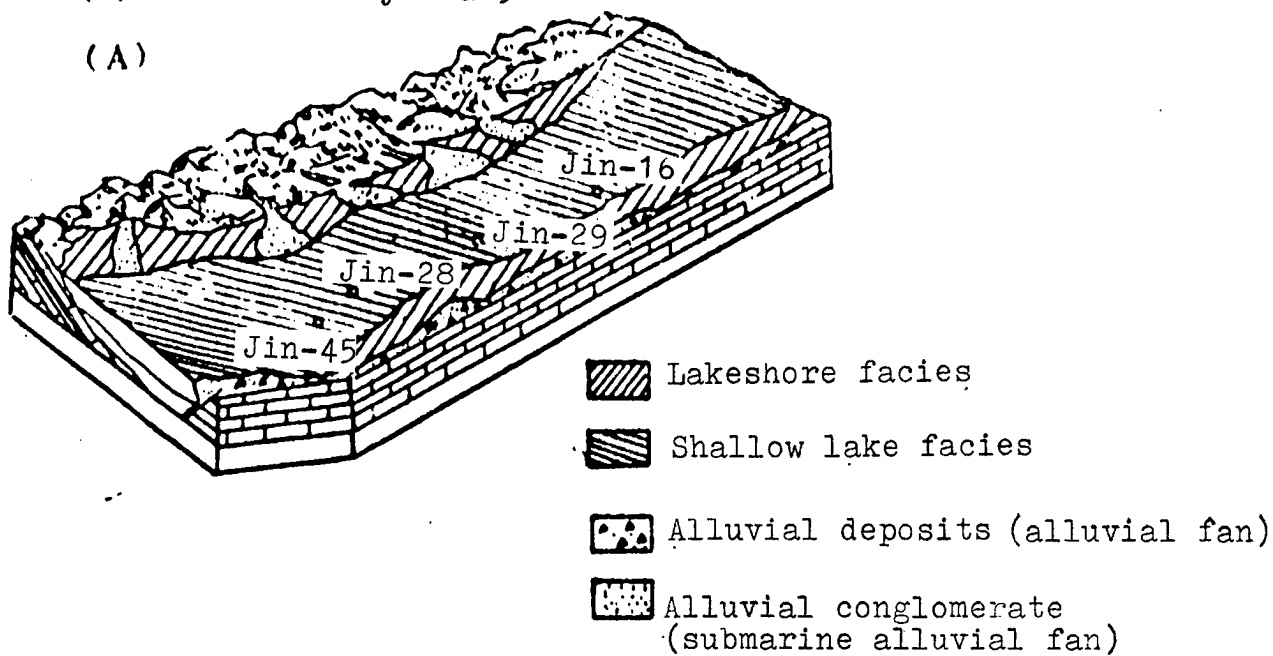
Figure 4. Seismic Facies Characteristics of the SL82-909 Profile

of the region certainly show alternating strong and weak reflection wave groups. This characteristic can be traced over a wide area, over a range of as much as 100 square kilometers (see Figure 5), indicating that it is a suite of broad sheet sand bodies. For this reason, this stratum of sheet sand bodies can be found throughout the scope of alternating fluviolacustrine facies zones on model facies diagrams of the late Sha-2--Sha-3 member. Furthermore, they are located exactly on top of the early period of the Sha-2--Sha-3 member. They were extremely favorable for the capture of oil and gas.

3. The formation of oil and gas pools requires sheltering conditions at appropriate times. Permeable sand bodies are distributed widely within the Sha-2 and Sha-3 member alternating fluviolacustrine facies zones and they also are excellent oil generating strata. If excellent sheltering conditions were absent at the time, the oil and gas would be piped into the sand strata, and it also flowed through them and could not form good oil and gas pools. There is an excellent widely distributed sheet sand body beneath the T₄ reflection stratum on the SX81-2 structural development profile chart. Two contemporaneous faults formed in the Sha-2--Sha-3 member strata after the Dongying group of sediments, one of them in the Jingqiu region and the other in the Checheng-Caogu region. Fault activity continued up to the Guaotao group of sediments, and the Sha-3 oil generating strata already had entered the oil generating window by that time. It began to be transformed into hydrocarbons and was followed by hydrocarbon discharge. For this reason, the oil and gas began its preliminary movement into the sheet sand bodies and flowed to high positions along this sand body. The formation of the two faults at Jingqiu and Checheng undoubtedly played a role in sheltering and thereby capturing the oil and gas. It is not hard to infer from the present industrial oil and gas flows obtained in the Jingqiu region that it is possible that the Checheng-Caogu region, which was under similar conditions, may be another site of oil and gas capture. For this reason, a favorable facies zone of a generating, reservoiring, and capping combination added to a matching trap are essential basic factors for the formation of oil and gas pools. Otherwise, it would be like the location in the area of the Jin-28 well where, despite the fact that there are excellent favorable conditions of a generation, reservoiring, and capping match and where it was in a rather high position during the period

(A) Sha-2 + early Sha-3

(A)



(B) Sha-2 + late Sha-3

(B)

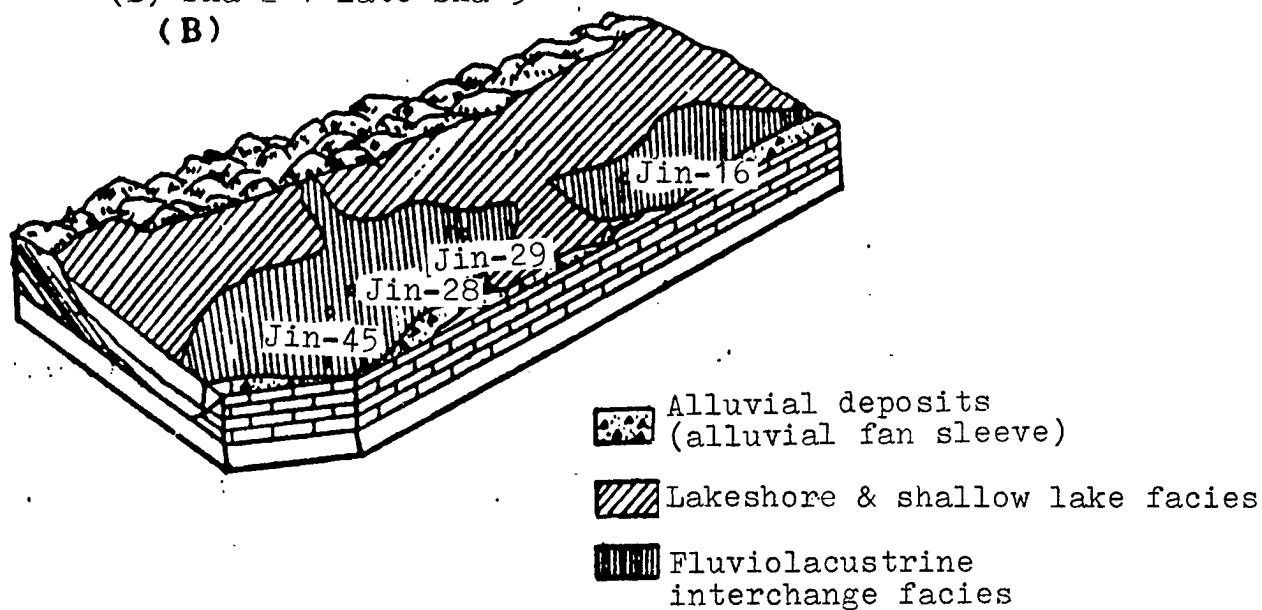


Figure 5. Sedimentary Facies Model for the Early Tertiary in the Shulu Depression

of hydrocarbon discharge, there were no excellent sheltering conditions and it could not capture oil and gas. Wells, therefore, obtained only indications of oil and gas and later tests only produced water, no oil flows.

In summary, the Shulu depression covers a small area but it does contain a large variety of traps. Moreover, it has rich oil flows as well as favorable oil reservoiring rock facies zones, so it can be said that it is a small but fertile new exploration region and therefore that it has pleasing prospects in the search for oil.

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OIL AND GAS

BRIEFS

DAQING SETS ANOTHER RECORD--Harbin, 31 Dec (XINHUA)--The Daqing oil field in northeast China's Heilongjiang Province has produced 387 million barrels of oil this year, the highest annual production in the past decade. The oil field has achieved an average annual increase of 3.5 million barrels since 1976 when it produced 350 million barrels of oil, according to the oil field's administration bureau. During the past decade, Daqing has produced 126 million barrels of oil more than the state plan. Daqing's total oil output in the last 10 years reached 3,627 million barrels, about half of China's total. Daqing has achieved 598 scientific research findings including 57 state awards and 148 provincial and petroleum industry ministry awards. [Text] [Beijing XINHUA in English 1025 GMT 31 Dec 85 OW] /8918

SICHUAN NATURAL GAS PRODUCTION--Chengdu, 12 Dec (XINHUA)--Sichuan Province has already topped its 1985 production quota of natural gas, provincial officials said here today. The province is China's leading gas producer, with deposits and output accounting for more than half the country's total. It had produced 5.07 billion cubic meters of natural gas by the end of November, overfulfilling the planned annual target by 1 percent. The province has also found five new oil- and gas-bearing areas and dug 53 gas wells of commercial value so far this year, the officials said. [Text] [Beijing XINHUA in English 1436 GMT 12 Dec 85 OW] /8918

DAQING GAS STRIKE--Harbin, 18 Dec (XINHUA)--Oil workers at the Daqing oilfield in northeast China have obtained a natural gas flow of exploitable value from a test well at a depth of 2,800 meters. This is the first time the oil field has found natural gas at such a depth. Located in the Chaoyanggou area, the well is reported to yield 5,700 cubic meters daily. The discovery marks a big step in deep exploration at the oil field and testifies to the great prospects for natural gas reserves in the Songhua-Liaohe Basin. The oil and gas wells at the Daqing oil field are usually about 1,200 meters deep. [Text] [Beijing XINHUA in English 0722 GMT 18 Dec 85 OW] /8918

HUABEI HIGH-YIELD WELL--Beijing, 17 Dec (XINHUA)--A high-yield well was reported to have been drilled Sunday at the Huabei oil field, with a daily output of 2,172 tons of crude oil and 250,000 cubic meters of natural gas. It is the highest yielding oil and gas well ever drilled in the southern area of the Huabei oil field. This well will help the oil field to maintain its annual output at 10 million tons. Huabei oil field, China's third largest after Daqing and Shengli, yielded 5.17 million tons of crude oil in the first 6 months of this year. [Text] [Beijing XINHUA in English 0904 GMT 17 Dec 85 OW] /8918

ZHONGYUAN 1985 OIL OUTPUT--By 2 December, annual output of crude oil from Zhongyuan oil field, Henan Province, had exceeded 5 million tons. Its total output of crude oil is now some 170 million tons and an average increase of 43.1 percent was recorded a year. The total amount of money submitted to the state by the oil field has been some 460 million yuan. [Summary] [Zhengzhou Henan Provincial Service in Mandarin 1030 GMT 9 Dec 85 HK] /9738

ZHONGYUAN BEATS DRILLING TARGET--This year [1985], 32 teams have drilled a total depth of over 10,000 meters, 13 have drilled a total depth of over 20,000 meters, and three have drilled a total depth of over 30,000 meters. The oil field as a whole has fulfilled 18 days ahead of schedule the target of drilling a total depth of 1.1 million meters. The oil field's oil prospecting bureau deployed 85 teams in areas rich in natural gas deposits both north and south of Huanghe. The bureau also sent a team to prospect oil deposits in the peripheral area of the oil field. On average, this year's designed depth of drilling has increased by more than 100 meters. [Summary] [Zhengzhou Henan Provincial Service in Mandarin 1030 GMT 23 Dec 85 HK] /9738

HUANG HE DELTA DEVELOPMENT--Shandong Province is now developing the Huang He Delta, building a modern petrochemical base and developing agriculture and animal husbandry. From last year until today, more than 130 groups (more than 700 individuals) of foreign economists have conducted inspections and held talks on cooperative matters. China's second largest oil field, Shengli, and a newly built petroleum industry city, Dongguan, are located in the Huang He Delta. According to the State Plan, Shandong Province will develop the delta's oil, agriculture, animal husbandry, fishing and aquatic products industries. In the Seventh 5-Year Plan, more work will be done to turn the Huang He Delta into a modern petroleum and petrochemical base; Shengli's yearly crude output will reach 50 million tons and corresponding petroleum refineries, and petrochemical and chemical fertilizer industries will be built. [Excerpt] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 7 Oct 85 p 1] /12232

LIAOHE GAS TO SHENYANG--Up until today, Liaohe oil field has shipped via pipeline more than 8 million cubic meters of natural gas to Shenyang. The 44 km pipeline from Liaohe to Shenyang has been under steady pressure since it went into operation more than a month ago and has piped gas regularly. Currently, Liaohe's natural gas is also being shipped to Anshan, Liaoyang, Liaozhong, and other cities and counties, and a pipeline to Benxi will soon be completed. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 1 Dec 85 p 1] /9604

NEW HEBEI WELL--On 27 October, the No 2 Oil Prospecting Co. of the Huabei Petroleum Administrative Bureau succeeded in drilling a fine-quality and high-yielding oil well in Ningjin County, Hebei Province. The daily capacity of this well is 300 tons of crude oil and 30,000 cubic meters of natural gas. According to the analysis of oil experts, the well may yield more than 1,000 tons of crude oil daily after acidation. /Text/ /Shijiazhuang Hebei Provincial Service in Mandarin 2300 GMT 4 Nov 85 SK/ 12228

NUCLEAR POWER

PRICE DISPUTE RUMORED IN DAYA BAY NEGOTIATIONS

HK030415 Hong Kong HONG KONG STANDARD (BUSINESS STANDARD SUPPLEMENT) in
English 3 Dec 85 p 1

[By Meiling Liu]

[Excerpt] Negotiations over China's first nuclear power plant in Daya Bay, estimated to cost U.S. \$3.5 billion, are now in the final stages.

This was said yesterday by Mr Christian Adams, senior British Trade Commissioner in Hong Kong.

He told reporters that Britain's General Electric Company (GEC) hopes to reach an agreement with China on the Daya Bay Plant before Christmas.

The GEC, who are presently negotiating in Beijing, is seeking to supply conventional generators for the plant which is to be built in southern Guangdong.

Framatome of France, the third party bidding for the project, plans to provide two 900 MW nuclear reactors.

The plant is slated to produce electric power mainly for neighbouring Hong Kong when it is completed in 1991.

In October, China asked the two companies to cut their prices by 20-25 percent.

However, Mr Adams did not indicate whether GEC had agreed to cut its price.

Mr Adams confirmed that British companies' interests in doing business with Hong Kong was increasing.

In 1984, 59 offices were set up in the territory. This year a number of big firms such as Rolls Royce (aircraft engines), Short Brothers (aircraft), Davey McKee (engineering) and GEC Telecommunications, had established offices here, he said.

/8918

CSO: 4010/22

NUCLEAR POWER

FINANCIAL PROBLEMS PLAGUE TROUBLED DAYA BAY PROJECT

Hong Kong HONG KONG STANDARD (BUSINESS STANDARD SUPPLEMENT) in English 14
Dec 85 p 1

[Article by Sheila Dawes in London]

[Text] Financial problems with China's first two nuclear power plants call into question their economic viability and suggest the Guangdong nuclear power plant may not even get off the ground, the [professional] journal NUCLEAR ENGINEERING INTERNATIONAL suggests in its December issue.

It says: "The smart bet is that Guangdong's key project will be shelved for at least 2 years."

The journal claims that the project is now in the doldrums, and a number of people are trying to distance themselves from it.

"At least one senior official from Guangdong Province no longer attends its board meetings, and it is rumored in Hong Kong that China Light and Power Company is trying to reduce its commitment, if not withdrawing altogether."

A decision by the Central Committee of the CPC to make the Daya Bay nuclear power station the key project for Guangdong Province in the Seventh Five-Year Plan starting next year has come at an embarrassing time for the joint venture which will own the plant, NUCLEAR ENGINEERING INTERNATIONAL says.

"Under the terms of the agreement for setting up the joint venture, it was envisaged that China Light, the Hong Kong partner, would receive 25 percent of the station's output, in line with its share of the investment, at a base cost.

In addition to this, China Light would purchase up to 45 percent more from the Chinese partner at a higher price.

The agreement stipulated that the price to be paid for the power by China Light would not be greater than that from any equivalent coal-fired station constructed at the same time and in the same place.

An appendix gave this as a function of the price of coal.

CSO: 4010/29

NUCLEAR POWER

FRAMATOME CLOSE TO AGREEMENT ON SUPPLY OF DAYA BAY REACTORS

HK090501 Hong Kong SOUTH CHINA MORNING POST in English 9 Dec 85 p 1

[By Albert Chan]

[Text] French equipment manufacturer Framatome is close to an agreement with China to supply two nuclear reactors for the Daya Bay nuclear power plant.

Sources said final negotiations hinged on narrowing a gap of about 25 million francs (about HK\$25 million) in the 10 billion franc contract. They said the deal could be settled by Christmas.

It was learned that the French and Chinese had already agreed on the exact scope of supply, and bargaining was now purely on prices. But the British were said to be lagging slightly behind in separate negotiations for the supply of turbine generators.

One source said they were still having technical discussions about how supply could be modified to cut overall costs.

On the other hand, the latest round of talks between the French and Chinese in Beijing, which began in the middle of last month, was reported to have made considerable progress.

A French source, while confirming the 25 million franc gap, said it was "relatively easy to fill."

Another source said the final deadline for signing the two key contracts had been set for March.

Britain's General Electric [GEC] Co and Framatome of France are expected to sign letters of intent with the Chinese within the next 2 months.

The chairman of China Light and Power Co [CLP], Lord Kadoorie, said in the latest company review released late last month that contracts were expected to be awarded early next year.

But he did not refer to any deadline nor would he disclose specifically which month the contracts would be awarded.

Sources said the March deadline was "the deadline that has to be met" to avoid any further delay.

The original timetable stipulated that formal contracts with equipment suppliers were to be concluded before the end of this year and construction was to begin early next year.

According to that schedule, the first reactor of the power plant should be ready to supply electricity by early 1991, well before the expected summer peak.

CLP will buy 70 percent of electricity from the Daya Bay plant, as agreed between the company and the Guangdong authorities.

Since CLP's own Castle Peak plant will have been fully operational by 1990, a new power plant has to go on stream by 1991.

After protracted technical discussion, the first round of price negotiations began in summer.

The second round took place in October, but wide gaps in price and loan arrangement terms brought about a deadlock, with the British GEC reportedly considering quitting the project.

The current round started in the middle of last month and officials stressed that there was continuous progress over the past 3 weeks.

The Chinese Vice-Minister of Water Resources and Electric Power, Mr Peng Shilu, told the SOUTH CHINA MORNING POST that the Chinese side had conceded certain points during the talks.

"We agreed to modify the 'options' in the contracts by cutting some of the minor spare parts in order to lower the price."

Meanwhile, it was confirmed that the British trade delegation led by Lord Young, a former minister without portfolio, would not discuss the Daya Bay project during a visit to Beijing later this week.

/8918

CSO: 4010/22

NUCLEAR POWER

MAIN PLANT BUILDINGS AT QINSHAN SITE TAKING SHAPE

Shanghai JIEFANG RIBAO in Chinese 1 Nov 85 p 1

[Text] Construction work on the Qinshan nuclear power plant--the first such facility to be designed and built by China--has entered a 'high tide' of activity, with the main plant buildings now rising 10 meters out of the ground.

The chief engineer of the Qinshan nuclear power plant, Ou-yang Yu, briefed a XINHUA reporter in Beijing on 30 October on the status of the 300MW facility. He stated that since construction work on the main buildings of the Qinshan nuclear power plant commenced in January [1985], the concrete foundations had been completed by the end of June. At the present rate of progress, the civil construction could be finished by the end of next year [1986]; installation of the equipment will begin early in 1987 and could be completed in 1988. Tests are scheduled for early 1989 with actual power production beginning sometime that year.

Ou-yang Yu stated that a significant aspect of this Chinese-designed and built nuclear power plant is the systematic mastery of nuclear power plant construction technology and the assimilation of imported nuclear techniques.

There are now three more nuclear power plants either under construction or planned: the Guangdong nuclear power station and the nuclear power plants to be built in Jiangyin County, Jiangsu Province, and on the coast of Liaoning Province, for which sites have already been selected.

/9604

CSO: 4013/49

NUCLEAR POWER

PREPARATORY WORK COMPLETED ON GUANGDONG PLANT

HK231338 Beijing XINHUA Hong Kong Service in Chinese 0231 GMT 23 Dec 85

[Text] Guangzhou, 23 Dec (XINHUA)--The preliminary preparatory work for the Guangdong nuclear power plant has been basically completed and large-scale construction is to be started next year.

From April of last year to now, the nuclear power plant has completed the construction of a 28-km road linking the Hong Kong-Shenzhen Road, built a reservoir with a storage capacity of 1.3 million cubic meters, erected a 35,000-kilowatt power transmission line, installed 400 telephones, and has basically completed a breakwater which is about 1 km long. In addition, the construction of a 200 kV transmission line and a 480-line microwave information system is being speeded up.

The two hilltops on the plant's work site, which are 67 and 38 meters high, have been levelled and a total of 250,000 cubic meters of coastal fill has been created by flattening the hills, on which a nuclear island and conventional island as well as auxiliary buildings will be erected. According to statistics, the construction of the whole nuclear power plant will need 2.7 million cubic meters of earth and stone, of which 2.1 million cubic meters has been obtained, comprising more than 80 percent of the total earth and stone needed.

/9738

CSO: 4013/45

NUCLEAR POWER

NUCLEAR POWER PLANT SITE SELECTION AT HANGZHOU BAY DETAILED

Beijing SHUIWENDIZHI GONGCHENGDI ZHI [HYDROGEOLOGY AND ENGINEERING GEOLOGY]
in Chinese No 4, 15 Jul 85 pp 10-12, 59

[Article by Wang Jinxing [3769 6855 2502]: "A Discussion of Regional Stability of Foundation of Nuclear Power Plants on the Northern Bank of Hangzhou Bay Based on Satellite Gravitational Data"]

[Text] This article will attempt to apply satellite gravitational measurement data to study the mantle current stress field and the source of the driving force in crustal deformation, and it will discuss deep geological structures and their relationship to earthquakes to provide basic data for evaluating the stability of regions selected as sites for nuclear power stations.

I. Calculation of Mantle Current Stress Fields

According to the earth gravitational potential spherical resonance function coefficient announced by C.A. Wagner and others in the United States and the mantle convection model and stress formula derived by S.K. Runcorn, the stress component caused by mantle convection flowing to the east and north is:

$$\sigma_E(\theta, \lambda) = \sum_{n=13}^{25} \sum_{m=0}^n Mg/4\pi a^2 [(a_0/a)^{n+1} \cdot (2n+1/n+1) \cdot 1/\sin\theta P_n^m(\cos\theta)] [-m\bar{C}_{n,m} \sin(m\lambda) + m\bar{S}_{n,m} \cos(m\lambda)] \quad (1)$$

$$\sigma_N(\theta, \lambda) = \sum_{n=13}^{25} \sum_{m=0}^n Mg/4\pi a^2 [(a_0/a)^{n+1} \cdot (2n+1/n+1)] \cdot d/d\theta [P_n^m(\cos\theta)] [\bar{C}_{n,m} \cos(m\lambda) + \bar{S}_{n,m} \sin(m\lambda)] \quad (2)$$

In the formula, M = quality of the earth; g = gravitational acceleration; a_0 = radius of the earth; a = radius of the upper spherical surface of the mantle current; λ = longitude; θ = colatitude; $P_n^m(\cos\theta)$ = the associated Legendere polynomial for the n th step and the m th instance argument of θ ; $\bar{C}_{n,m}$ and $\bar{S}_{n,m}$ = gravitational potential spherical resonance function coefficient.

While making inferences from the above formula, it is assumed that the mantle material is a Newtonian viscosity laminar viscous flow and that the viscosity coefficient is a constant. Moreover, it is felt that the effects of the lower hemisphere of the mantle current can be ignored, and it is assumed that the lithosphere of the upper surface of the mantle current is an elastic shell and that the tangential component of the flow velocity of this upper hemisphere is 0. Therefore, the resultant stress created by the drag of the mantle current on the lower hemisphere of the crust is:

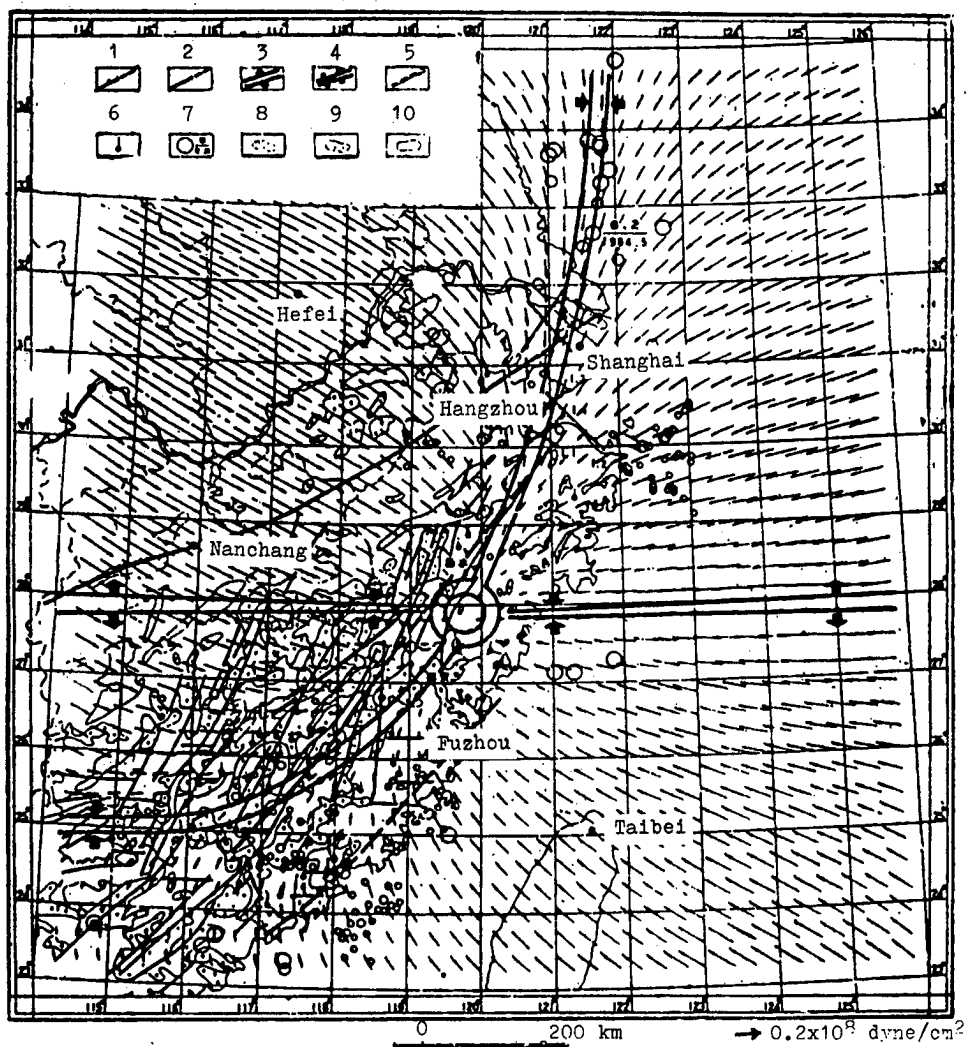
$$Q(\theta, \lambda) = [\delta_E^2(\theta, \lambda) + \delta_N^2(\theta, \lambda)]^{1/2} \quad (3)$$

whose orientation is

$$\alpha(\theta, \lambda) = \tan^{-1}[\delta_N(\theta, \lambda)/\delta_E(\theta, \lambda)] \quad (4)$$

In the calculations made in this article, we selected the short wavelength mantle current system related higher order gravitational potential resonance function (13-25) order and derived the radius of the earth as $a_0 = 6,378$ kilometers and the radius of the upper interface of the mantle current $a = 6,278$ kilometers. The range of calculations was 23° to 35° north latitude and 114° to 126° east longitude in steps of $18'$ and we used a $0.3^\circ \times 0.3^\circ$ tetragonal grid to calculate a total of 1,521 coordinate points. All of the data was processed with an electronic computer. The mantle current stress field calculated for southeastern China is shown in Figure 1. The maximum stress intensity was 0.8×10^8 dynes/cm² and the minimum stress intensity was 0.2×10^7 dynes/cm². The general stress intensity was over 0.5×10^8 dynes/cm².

Figure 1. Mantle Stress Fields in the (13-25) Order below Lithospheric Strata in the Zhejiang-Fujian Region



Key:

1. Geologically inferred ancient plate subduction zone
2. Geologically inferred deep fracture
3. Compressional stress axis
4. Compression-extension stress axis
5. Active linear structures from satellite images
6. Hot springs
7. Earthquakes above grade 4
8. Magmatic rock
9. Pre-Cambrian metamorphic rock systems
10. Fault subsidence basin

II. Reflected Depth of the Mantle Current Stress Field (13-25) Order

This article adopted the earth gravitational potential spherical resonance function higher order coefficient to reflect the depth of the mantle current. Marsh et al. (1972) felt that the depth of the higher order source is about 200 kilometers. Khan (1972) felt from consideration only of the changes in individual density that the depth of the greater than 11 order source was 300 to 600 kilometers. Allan felt that the depth of the (7-22) order source was about 50 to 260 kilometers.⁽⁴⁾ Although the figures are different, they do permit the derivation of a general outline, which is that the depth reflected by the higher order field is located between the upper and lower mantle in the so-called mantle transition zone. This view provides a new and important confirmation of gas isotope ratios and considers the concepts of mantle laminar convection model to be identical.

III. Characteristics of the (13-25) Order Mantle Current Stress Field

It is clearly visible on stress field charts that there is a concentrated center of stress and that there are corresponding levorotatory and dextrorotatory stress fields. There is an obvious center of concentrated stress between Lishui in Zhejiang Province and Fuan in Fujian Province. Surrounding this center of concentration is a torsional compression stress axis with a NE-SW orientation and a "wedge" shaped compressional-extensional shear stress axis with a nearly east-west orientation that are composed of a dextrorotatory stress field on the NW side, a levorotatory stress field on the NE side, a levorotatory stress field on the SW side and a dextrorotatory stress field on the SE side. The NE end of this compressional stress axis with a NE-SW orientation extends from the center of concentration across Zhejiang, through Shangyu and across Hangzhou Bay, through Haiyan and into Taican and Haimen in Jiangsu, where it turns to a nearly north-south orientation and enters the Huang Hai [Yellow Sea]. Its south-western end begins at Pingnan in Fujian and passes through Youxi and Longyan into Jiangxi. As understood now, its length is about 1,800 kilometers.

There is a "wedge" shaped compressional-extensional shear stress axis with a nearly east-west orientation that surrounds the center of stress field concentration and matches the compressional stress axis with a NE-SW orientation. This axis mainly involves compressional shear stress near the center of concentration but creates an extensional shear stress field at the boundary line far from the center of concentration because of differences in the direction of rotation in the stress field. The above characteristics are the source of the driving force for the criss-crossed complex geological structures, and they also induce the mechanisms of the source of force of earthquakes.

IV. The Relationship Between Mantle Current Compressional Stress Fields and Earthquakes

The concentrated stress field indicates that there is a downward-moving mantle current in this region. The stress created by mantle convection

drags along the lithosphere above it. The compressional stress creates compression and collision in the lithosphere and causes torsional deformation and folding on a large scale. Energy accumulates continuously as a consequence of the torsional deformation process and causes fracturing in the lithosphere when it reaches a certain degree, leading to magmatic intrusion, volcanic eruptions, the danger of earthquakes and other outcomes.

Research on the mechanisms of earthquakes indicates that when the drag of the torsional stress field caused by mantle convection leads to compression and collision in the lithosphere, friction occurs mainly in the zone of the compressional stress axis and energy continues to accumulate. When the compressional stress energy reaches the maximum limit of lithosphere fracturing, the energy must be released, causing an earthquake. After the energy is released, a period of stability is maintained in the lithosphere and it begins to accumulate energy gradually once again, the cycle repeated over and over. This is the origin of the continual and frequent occurrence of shallow earthquakes in this region. It can be seen from historical earthquake data that the earthquakes in this region have two obvious characteristics. One is that the distribution of earthquake epicenters forms a zone in a NE orientation and a block with a NW orientation. The epicenters are distributed along the zone and appear in groups of blocks. The Yaosha-Wunengsha region of the Huang Hai, for example, is a landmass where strong earthquakes have occurred in groups in this earthquake zone. Another characteristic is that earthquakes are stronger in the north and weaker in the south. In the southern Zhejiang-Fujian region, for example, the rate of earthquake occurrence is less and they are of less energy intensity. This may be due to the conversion of mechanical energy arising from crustal friction being converted directly into heat energy that appears as hot springs. The result is that earthquakes within Fujian are greatly reduced in number and intensity, which is the reason for the greater number of hot springs and higher temperatures. It is obvious that earthquakes and geothermal [energy] have an obvious "homogenetic heteromorphic" relationship in this fracture zone.

V. A Discussion of the Regional Stability of the Foundation at the Site of the Nuclear Power Plant on the Northern Bank of Hangzhou Bay

Every nation has special regulations and standards for evaluating each phase of nuclear power plant site selection. Although China does not have formal standards for evaluating the phases, the Ministry of Water Resources and Electric Power feels that the three primary factors during the nuclear power plant site selection evaluation stage are seismic geology, engineering geology and hydrogeology, and environmental protection. Of these, seismic geological conditions have become known as the highest technical safety standards for construction of nuclear power stations.

All three of the sites at Jinshan, Zhapu and Qinshan on the northern bank of Hangzhou Bay that have been selected as sites for nuclear power stations are located in a zone of mantle current stress field compressional stress. At the surface there are the Xinhuaxia system (the Lishui-Shangyu fracture extends north across Hangzhou into the Haiyan and Jiashan region) and the

Huaxia system (the Xiaoshan-Qiuchuan fracture) directional active fractures that pass through the area of the selected sites and which are the fracture zones that give birth to earthquakes. Secondly, there is the active fracture that extends in an east-west direction (the Hangzhou Bay deep sea trough) along the seacoast in the area of the selected sites. Historical data on earthquake epicenters indicates that the great majority of the strong earthquakes in this region are closely related to the Xinhuaixia system of fractures and that most of them occur in the region of the intersection of the Xinhuaixia active fracture and the main latitudinal active fractures. Those already known include the Yaosha-Wunansha zone in the southern Huang Hai region.

According to incomplete statistics, more than 100 earthquakes, some of them destructive, have occurred on the northern bank of Hangzhou Bay between the start of record-keeping in 294 A.D. and now, as shown in the following table.

Table 1. Statistics on Seismic Activity in Some Regions North of Hangzhou Bay

Location	Number of earthquakes	Number of destructive earthquakes	Earthquake characteristics		Record of destruction
			Earthquake grade M ₃	Epicenter intensity	
Haining	15	1	5	6	September 1867
Haiyan	12	1	4 3/4	6	26 May 1678
Zhapu	2				
Jinshan	37	1			August 1689 Caused the sides of bridges to incline, the sound of earth splitting, about 2 feet, fractures subsided as ponds
Jiashan	44				
Jiaying	26		4 3/4		May 1560
Songjiang	25	2	5	6	1 September 1624 Lasted for 5 minutes, doors, windows and other things broken.
Tongxiang	12	1	4		January 1756
Songde	17				

Note: Data on number of earthquakes and conditions from information supplied by Yu Zhiying, et al.

As the table shows, the earthquakes in the region of the northern bank of Hangzhou Bay have the characteristics of low grades and low intensity but a high rate of occurrence. The frequent earthquake activity indicates that this region has rather poor stability conditions and the frequent occurrence of seismic phenomena undoubtedly is an indication of modern crustal movements.

Satellite photograph images show two distinct images of linear structures on the northern bank of Hangzhou Bay with NE and NW orientations, that the L linear structure with a NE orientation controls the northern bank of Hangzhou Bay and the deepwater trough of Hangzhou Bay extends along L, and that it is an active Quarternary structure. This interpretation of satellite photograph images is confirmed by geophysical data. Data from shallow sea strata profiling indicates that there is a deepwater trough in Hangzhou Bay and that there is a fracture structure on either side. The deepwater trough reveals a fracture destruction zone that has obvious indications of subsidence. The shape of aeromagnetic ΔT and marine magnetic ΔT curves has the same characteristics. The deepwater trough region is reflected as a linear negative magnetic field, indicating that the sedimentary capping strata in this linear negative magnetic field are rather thick. The characteristics of the gravitational field are even more obvious. The northern bank of Hangzhou Bay is a positive gravitational field and the southern bank is a negative gravitational field, while the Hangzhou Bay that lies between the southern and northern banks is a zone of positive and negative magnetic distortion, an even more obvious indication of the existence of a fracture. All of the above data are consistent with the proposition that the deepwater trough of Hangzhou Bay is a fracture destruction zone and that new structural movements have caused continual and sustained subsidence on the northern bank of Hangzhou Bay. This phenomenon can be confirmed through the differences in distribution and depth of burial of the vestiges of ancient cultures on the northern bank of Hangzhou Bay. Based on the discovery of the vestiges of ancient settlements and cowries from the Wang Mang era under the especially dry tidal surface south of the Zhapu mountain group, Chen Jiyu [7115 0679 0151] has calculated that the northern bank of Hangzhou Bay subsides at a rate of 2.7 mm annually.² This figure can be used as a reference for the modern rate of subsidence activity. The average high tide level at Zhapu at the current time is 3.74 meters, while the historical remains are 5.30 meters below the current average high tide level. Such a large drop is an obvious indication of crustal subsidence at the northern bank of Hangzhou Bay. This illustrates fully that new structural movement exists and moreover that it is active.

In summary, we feel that the northern bank of Hangzhou Bay is a region of continual crustal subsidence and that its regional stability is not sufficiently ideal. Although the earthquakes are low grade ones of weak intensity, active Quarternary fractures exist, which has placed the vast plains region at the northern bank of Hangzhou Bay in a state of continual subsidence. Moreover, the Yaosha-Wunansha zone in the southern Huang Hai region is an area of intense and frequent earthquakes that lies within a range of 320 miles to the north of the site chosen for construction of a

plant. A level 6.2 earthquake occurred in this region on 21 May 1984. In this way, the recurrence of an earthquake could cause rather great seismic effects in the area of the northern bank of Hangzhou Bay near the active fracture and the obvious residual deformation could cause uneven subsidence, inclination, uplifting and slippage of the foundation, liquefaction of the load-bearing strata, crustal fracturing and other geological phenomena that could endanger the safety of the plant foundation.

VI. Conclusion

An examination of the deep structures at the three sites at Jinshan, Zhapu and Qinsan selected for construction of a nuclear power station on the northern bank of Hangzhou Bay indicates that they lie exactly in a zone of mantle current compressional stress. This zone is a deep geological structure fracture zone as well as the structural zone that gives rise to earthquakes. The deepwater trough in Hangzhou Bay also is an active structure with a nearly east-west orientation that controls the northern bank of Hangzhou Bay and places the plains region on the northern bank in a state of sustained subsidence. Moreover, the Yaosha-Wunansha belt in the southern Huang Hai region that lies within a range of 320 kilometers of the area selected for plant construction is a region of intense and frequent earthquakes. Based on comparison of the geological categories of earthquakes and beginning with the view of the possibility of a source area for reoccurrence of earthquakes in the active structural zone, the stability of the sites on the northern bank of Hangzhou Bay selected for plant construction could be faced with serious danger of unsafe geological phenomena and it should be avoided, or project designs should adopt the appropriate earthquake prevention and structural protection measures and take precautionary fortification and safety measures against liquefaction of load-bearing strata and uneven subsidence of the foundation.

This is the author's first attempt to use satellite gravitational data to study mantle current stress fields on combination with calculated confirmations based on historical earthquake data, geophysical information and vestiges of ancient cultures to discuss the regional stability for evaluation of sites selected for nuclear power stations, so it is possible that his limited levels may have led to many mistakes, which he hopes will be criticized and corrected. This author boldly proposes his doubts concerning the regional stability of the foundation of nuclear power stations on the northern bank of Hangzhou Bay and feels deeply that he has taken such a bold move only to provide a reference for site selection and policymaking departments and project design units.

Associate Professor Huang Peihua [7806 1014 5478] of the Chinese University of Science and Technology guided the computer calculations of the stress fields and provided computer data. The author would like to thank him here.

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FOOTNOTES

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NUCLEAR POWER

BRIEFS

DAYA BAY UPDATE--Guangzhou, 12 Dec (ZHONGGUO XINWEN SHE)--Construction of China's first large nuclear power plant--the Guangdong Daya Bay Nuclear power plant project--is being stepped up. The first-phase breakwater project is expected to be completed at the end of [1985]. The Dakeng Reservoir built to supply water for the plant was completed on 5 December. The plant's first-phase breakwater is 1,169 meters long and 11 meters high. After being completed, the project will be able to stand a typhoon measuring 12 on the Beaufort scale, thus providing conditions for the safe construction of the plant. With a capacity of 1.3 million cubic meters, the Dakeng Reservoir can supply water for the use of construction and people's daily life. The Daya Bay Nuclear Power Plant, China's largest joint-venture project using Chinese and foreign investment at present, is to have two 900MW nuclear generating units. The plant is scheduled to be completed in 1991. [Text] [Beijing ZHONGGUO XINWEN SHE in Chinese 12 Dec 85 HK] /9738

CSO: 4013/45

SUPPLEMENTAL SOURCES

BRIEFS

NATION'S FIRST SOLAR POWER STATION--Gansu, 8 October--China's first solar energy photoelectric power station has been completed and is generating power. This solar energy photoelectric unit consists of 214 silicon photoelectric cells, a frame, storage batteries, a direct current/alternating current converter, and a power control system. With a rated power of 2000 Watts, it can provide electricity for lighting for more than 130 peasant households and 14 units. [Summary] [Taiyuan SHANXI RIBAO in Chinese 10 Oct 85 p 3] /12232

NEI MONGGOL WIND GENERATORS--Nei Monggol is striving to develop the production of wind generators. According to statistics, Nei Monggol now has 11 enterprises producing main generators and the necessary equipment, and their production capability has reached 10,500 generators. Last year they produced more than 8,600 generators, or 64 percent of the nation's total. In recent years, in order to change the backwards situation in grasslands, forests and mountainous regions, the Nei Monggol Autonomous Region Machinery Office made great efforts to develop wind generators. As of last year, they had already successfully developed eight different wind generators, including a 50-Watt model, a 100-Watt model and a 2-kilowatt model which have already entered batch production. The 100-Watt wind generator of the Commercial Department's Animal Husbandry and Machinery Office has undergone 4 redesignings and 27 improvements, and its production costs have decreased 54 percent. Its price is the lowest in the country for similar products, and last year it won an award as an outstanding product. Because these wind generators are inexpensive, of outstanding quality and extremely appropriate, they have already been sold in more than 20 provinces, municipalities and autonomous regions. [Text] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 5 Oct 85 p 3] /12232

CSO: 4013/29

CONSERVATION

GANSU GIVES HIGH PRIORITY TO ENERGY CONSERVATION

HK240845 Lanzhou Gansu Provincial Service in Mandarin 1100 GMT 20 Dec 85

[Text] A 4-day provincial meeting on energy conservation was concluded in Lanzhou this morning. This meeting reviewed our province's work in energy conservation during the Sixth Five-Year Plan, summed up experiences, arranged energy conservation work during the Seventh Five-Year Plan and next year, and discussed the revised provisional regulations and Gansu's detailed rules on economizing energy resources. Representatives at the meeting exchanged experiences in economizing energy.

This year, Lanzhou Petrochemical Industrial Machinery Plant, Gansu Rare Earths Company, and state-run Factory No. 404 were assessed by the state as advanced enterprises in conserving energy resources and won silver medals. Eight units, including Lanzhou Carbon Plant, state-run Factory No. 504, and the Fifth Nitrogenous Fertilizer Plant, won the honorary title of national commendatory enterprise for conserving energy resources.

At the meeting, on behalf of the State Economic Commission, the Provincial Economic Committee awarded citations and medals to these units. To further promote the development of energy conservation work the Provincial Economic Committee decided to carry out the activity of learning from the progressive, reducing energy consumption, and raising the level of energy conservation on the industrial and communications fronts throughout the province.

At the meeting, Vice Governor (Zhang Wulu) made a report, proposing that the key point of conserving energy next year is to economize on electricity. Moreover, he demanded: Leaders at all levels on the industrial front throughout the province must regard the improvement of the quality of products and the reducing of energy consumption as life-and-death matter for the enterprises and resolutely curb the trend of attaching importance only to increases in production capacity and disregarding the reduction of consumption.

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CSO: 4013/45

CONSERVATION

BENEFITS OF HYDROPOWER OVER FIREWOOD DISCUSSED

Wuhan NONGTIAN SHUILI YU XIAOSHUIDIAN [IRRIGATION AND DRAINAGE AND SMALL HYDROPOWER STATIONS] in Chinese No 9, 30 Sep 85 pp 30-33

[Article by Li Ying [2621 3576] of the Ministry of Water Resources and Electric Power: "Substitution of Small-Scale Hydropower for Firewood--Benefits and Policies"]

[Text] Preface

China has shortages of coal, petroleum and other fuels at the present time. The energy shortage is even more serious in rural areas and there is a shortage of about one-third for civilian fuels. The peasants are compelled to find their fuel by cutting trees, pulling up grass and burning straw. According to statistics for Liangshan autonomous prefecture in Sichuan, annual consumption of forest resources over the past 30 years has averaged 3.03 million cubic meters. Of this amount, 50.5 percent of forest resource consumption is accounted for by wood used as fuel by urban and rural residents. Industrial production also consumes large amounts of timber. The Guanyang County Candied Date Plant in Guangxi, for example, burned 1.5 million jin of firewood during less than 2 months' production time. A distillery with annual output of 100 tons burns 4.5 million jin of firewood each year. Timber cutting in excess of the amount being grown is common. This has led to ever-shrinking forest resources, ever-lower coverage rates and a loss of control over the ecological equilibrium. This has brought serious disaster to middle and downstream areas of rivers. According to incomplete statistics, about 5 billion tons of fertile soil are being lost in China each year. The amount of nitrogen, phosphorous and potassium fertilizer it contains exceeds total output from all the chemical fertilizer plants in China.

Although leaders in all areas have shown a great deal of concern for forest protection and have worked hard to advocate afforestation, the fact that there are no other energy resources that can be substituted for the energy needed to heat water for cooking means that the peasants value it dearly and must work hard at finding ways to find fuel. The result in some areas has been that "afforestation goes on year after year, but there never are any forests."

China's vast rural areas contain rich hydropower energy resources. According to preliminary statistics from 1980, China has about 150 million kW in latent hydropower potential, 70 million kW of it developable for annual power output of about 200 billion kWh. About half the counties in China have more than 10,000 kW that can be developed. Installed generator capacity at small scale hydropower stations in China has reached 9,066,600 kW and annual power output is 20.8 billion kWh. Practice has proven that small scale hydropower is a cheap energy resource in rural areas and that it plays an important role in achieving rural electrification, promoting the development of local industry and agriculture and improving the material and cultural standard of living of the peasant masses. The major changes in the amount of water that are caused by uneven precipitation between flood and dry periods give small scale hydropower output an obvious seasonal character. According to statistics for 11 counties with a total installed capacity of 128,000 kW, they had about 48,100 kW in excess electrical power during wet periods and 168 million kWh in surplus electrical power through an entire year, so there is great potential. The fact that seasonal electrical power could not be used has had serious effects on the results of small scale hydropower stations and on the masses' enthusiasm for managing power. This has made the question of using electrical power during wet periods and periods of valley power use an important task for small scale hydropower management. The development of electricity substitution for firewood in all areas is an effective route for resolving the contradiction between the rural fuel shortage and the waste of electrical power from small scale hydropower stations.

II. The Conditions for Substituting Electricity for Firewood

The use of thermal power equipment is strictly controlled in regions with serious power shortages like the east, north, northeast and other large power network electricity supply regions. There also are prohibitions on thermal power equipment for household use. This means that substitution of electricity for firewood must develop first of all in regions that receive electricity from small scale hydropower stations. Surveys indicate that the substitution of electricity for firewood can proceed rather smoothly in counties that meet the following three conditions:

1. They have large amounts of surplus power and power output from small scale hydropower stations, control over decision making on power supplies and an ability to set their own preferential prices. These are the preconditions of firewood substitution. Any blind development of loads for firewood substitution that fails to consider the actual supply capacity of small scale hydropower stations in a particular county inevitably will cause problems or even accidents. The price of electricity should not be decreased to the same level as for burning firewood since the user households who are substituting for firewood cannot bear the cost, and it also will be hard to extend and develop it.

2. There are local fuel shortages and serious shortages of firewood and coal. These are the social foundation conditions for firewood substitution. The cost of firewood in Jiangxi's Guangchang County in the past was only 0.7 to 0.8 yuan per dan but now has risen to 2 to 3 yuan or even higher, a 3.5-fold increase. In the past, the peasants of Shuang'an Brigade in Hunan's Cili County had to travel a round trip distance of 15 li to cut firewood but now have to travel more than 80 li. Peasants in Fujian say that now "we are not worried about what's in the pot, but what's under it makes us worry." The people of Jinyang County in Sichuan say that "anyone who can solve the firewood problem can become mayor of the county." It is obvious that the fuel problem has become something that concerns everyone. All counties that have serious firewood shortages should acknowledge the urgency of the situation. With attention by leaders, support by the masses and assistance from all sectors, progress inevitably will be smooth.

3. There must be a certain capital collection ability. This is the material condition for firewood substitution. Development of firewood substitution loads requires the readjustment of power transmission lines and transformer capacity. The regional differences in original power network layouts mean that there will be great variation in the investments required. Under normal conditions, the addition of 1,000 kW in thermal power equipment requires an investment of 30,000 to 100,000 yuan. For users, 40 to 60 yuan must be spent per household on the average for household hookups, meters and switches. It usually takes about 60 to 100 yuan for the electrical equipment used for heating water and cooking. This means that communes and brigades must have a certain capital collection ability and that the peasants also must have certain economic conditions. The alternative, reliance on the state, would make it impossible to use firewood substitution equipment over a wide area.

III. Types of Electricity Substitution for Coal

There now are 247 counties in China that have developed trial substitution of electricity for firewood. The firewood substitution equipment being used in the tests has a capacity of 680,000 kW, and 380,000 households have substituted electrical cooking for firewood. The equipment used comes in many forms and substitutes for firewood in many different ways. It can be placed in four general categories according to its use.

1. The type substituted for the firewood used in household daily life.

This refers mainly to substitution for the firewood that is used by households for cooking and heating water. Examples include using electric pots to cook rice, infrared ovens to make snacks, electric woks to stir-fry vegetables, electrical steamers to steam mantou [rice flour buns], quick-heating or electric water kettles for boiling water and so on. Additionally, there are electrically heated mattresses for warmth, electric water heaters for bathing and others. Of them, the thermal efficiency is highest for automatic electric pots to cook rice, infrared ovens for making snacks, fast-heating heaters inside thermoses that boil

water and some others. Each kWh of electricity can replace 4 to 6 jin of firewood. The masses have welcomed it a great deal. Although the selling price of electric space heaters is rather low, their thermal efficiency is less than 50 percent. They consume large amounts of electricity, are unsafe and should not be extended in large numbers.

2. The type substituted for firewood used to process agricultural products.

Firewood substitution of this type mainly involves electric tea making, electric tobacco curing, cereal grain drying, seedling raising in greenhouses and so on. The results of tests that use electricity to cure tobacco in Hunan's Lanshan County and Jiangxi's Shicheng County have been rather good. The results of using electricity to make tea have been best in Xinchang County in Zhejiang Province. Cereal grain drying equipment has been tested successfully in Sichuan Province's Dayi County. These thermal heating loads occur during the wet season. This is especially true of using electricity to make tea, since it can be processed at night during valley periods and is a rather ideal "firewood substitution" load.

3. The type substituted for firewood used to process large amounts of food products.

This type mainly involves a large amount of food processing in food product processing plants, restaurants, schools, factories, hospitals and other places. Examples include using large infrared ovens to bake bread, using electrically heated steamers to make rice, baozi [filled buns] and other things. The results have been rather good in small town restaurants in Guanyang and Zhaoping Counties [Guangxi Province] in the use of infrared equipment to boil porridge and make youtiao [fried dough sticks].

4. The type substituted for firewood burned for a large amount of heating.

This type mainly includes heating equipment used in factory production. Examples include electric kilns, electric boilers, electric heat used to make steam for distilling, sugar milling, curing prefabricated concrete pieces, hospital sterilization, steaming food and boiling water in factories and schools, and so on. Tests of electric kiln and oven technologies have been successful in Dehua County in Fujian. Each kWh of electricity can be substituted for 8 to 10 jin of firewood. The results have been very good using electric boilers for distilling liquor, steaming rice, heating drinking water, curing prefabricated concrete components and so on in Zhaojue County in Sichuan and Shicheng County in Jiangxi. The Yu'nán Water Turbine Plant in Jiangxi Province produces electric boilers (electric water heaters) with a volume of 0.35 cubic meters and an atmospheric pressure of 2 kg/cm. It has been inspected and approved by labor departments and can be marketed in all areas. Related scientific research departments have converged on Shanghai Municipality and now are developing a 0.2 ton/hour dual-purpose coal and electric boiler. Product approval is expected within the year. Electric boilers are important equipment to use as a substitute for the consumption

of large amounts of firewood. Their thermal efficiency can exceed 85 percent and each kWh can replace as much as 6 to 10 jin of firewood.

The results of 39 trials in these four categories have been that on the average one kWh can be substituted for 3.5 jin of firewood. Although the tests were carried out rather strictly, the type of stoves used in comparison and the quality of firewood were not completely identical, so a comprehensive calculation of the results of firewood substitution make it most appropriate to use a figure of 3 jin per kWh in the substitution of electricity for firewood.

IV. The Advantages of Substituting Electricity for Firewood

1. It reduces timber consumption, protects forest resources, prevents water loss and soil erosion and benefits the ecological balance. The Guibei distillery at Quanzhou in Guangxi originally had 12 coal and wood stoves that burned 300,000 jin of wood and 200 tons of coal each year. Ten of the stoves now have been converted to infrared electrical heating arrangements, which has reduced wood consumption to 50,000 jin and coal use to 65 tons each year. Liangshan autonomous prefecture has 9,100 kW in electric heating equipment that can replace 20,000 cubic meters of timber each year. The electric kiln at Dehua County in Fujian can save 4,000 cubic meters of timber each year. Forestry departments in Fujian Province consider the flood prevention results from 50,000 mu of forest with excellent vegetation to be the equivalent to a reservoir with a capacity of 1 million cubic meters. "Substitute electricity for firewood, conserve firewood and protect forests, use forests to protect water and use water to promote electricity," therefore, is one effective measure to use for turning ecological systems from vicious to benign cycles.
2. It solves problems for the masses and reduces expenses. Substitution of electricity for firewood, preferential pricing for electricity and the higher efficiency of electrical heating equipment in comparison to wood stoves generally can reduce household expenses by 20 to 60 percent. Statistics from Shang'an Brigade in Cili County, Hunan show that each household saves an average of 52.2 yuan a year.
3. It reduces labor intensity, saves time and protects health. Statistics for Pingjiang County in Hunan show that the number of working days the peasants spend cutting account for one-third of the total number of working days. When cooking with electricity, electric pots can shut off automatically and require no attention. This saves effort, work and time, and it is clean. The lack of smoke and fire protects health and plays a particularly large role in the health of the eyes. Moreover, electrification has moved into the kitchen. The use of electricity for cooking has led to improvements in the cultural life of the masses, improved everyone's spiritual state and embodies the superiority of the socialist system.
4. It improves the economic results of small-scale hydropower. Implementation of "electricity substitution for firewood" in the power networks of Guanyang, Quanzhou and Yousheng Counties in Guilin Prefecture permitted

them to generate an additional 5.24 million kWh of electricity and provided income from the electricity of 280,000 yuan. After developing loads to substitute electricity for firewood, Sichuan's Zhaojue County lowered the costs of the electricity it sold from 0.07 to 0.044 yuan per Kwh. Hunan's Cili County has calculated that the addition of each "firewood substitute" household could increase profits in its power network by 45 yuan per year. After developing the substitution of electricity for firewood, Fujian's Dehua County increased the utilization time of its power station by 1,140 hours and its yearly profits by 161,000 yuan. The results of implementation in all areas have confirmed that small scale hydropower stations bring about obvious economic results.

V. Some Related Policies That Must Be Decided

1. Implement a policy of preferential pricing for electricity usage during the rainy season.

Some provinces and autonomous regions already have informed us that they have implemented preferential pricing policies for electricity usage during wet seasons. An example is the "Notice Concerning Trial Implementation of Self-Determined Electricity Prices During the Wet Season," which is in Guangxi Price Circular No 128 (1982) issued by the Guangxi Autonomous Region Price Commission. It states clearly that small-scale hydropower stations in all counties can set their own electricity prices for rainy seasons. Prices are set slightly below current electricity prices on the basis of local power costs and the expenditure situation for wood and coal and in accordance with the principle of maintaining principal and slight profit. Some provinces, however, have made no clear decisions in this area and have ideological doubts about implementing them in all counties. We feel that a policy that allows floating prices for electricity is rather good. Preferential electricity prices should be implemented during the rainy season when there is a great deal of surplus power and regular prices should be implemented during the dry season when there is a power shortage. This is of real significance for encouraging electricity use as a substitute for firewood. Moreover, "electricity substitution for firewood" loads that can operate specially at night according to power network conditions and that can start up and shut down according to regulation orders should enjoy special preferential electricity prices.

It is best if the preferential electricity prices set for local areas approximate the costs of burning firewood or coal. They should not be too low. The reason is that the state has invested a great deal in construction of power stations and power line networks. The power stations must be maintained and sustain simple reproduction or they will be unable to continue operation. By setting electricity prices so that the amount of electricity used in high efficiency equipment is approximately the same as (or slightly lower than) the cost of burning firewood and coal, there will be no increased burden placed on the masses and the power stations can use the income from electricity sales to develop even more electricity usage and conserve even more wood. This would benefit the state and individuals.

2. Implement tax exemption policies to substitute electricity for firewood.

Electricity fees are rather low in the substitution of electricity for firewood at the present time. All areas should require that the government eliminate the 5 percent industry and commerce tax and other taxes in income from electricity fees involving substitution of electricity for firewood.

3. Implement a policy of using forests to subsidize electricity.

The substitution of electricity for firewood plays a major role in forest protection. For this reason, forestry departments should set aside a portion of their administrative expenditures for forest cultivation to subsidize hydropower departments. Sichuan's Aba Prefecture, for example, takes out 150,000 yuan each year for subsidies. The Liangshan Prefecture Planning Commission also plans to use a 10 to 15 yuan increase in the selling price of each cubic meter of wood to subsidize hydropower departments. According to our surveys, the amount of wood consumed each year by workers in forestry regions is rather shocking. The Leibo Forest Industry Bureau in Liangshan Prefecture, for example, employs 2,700 people who consume 10,000 cubic meters of finished lumber at no cost each year. Calculated at the local timber price of 98 yuan per cubic meter, they are consuming 980,000 yuan in materials each year. This sort of waste is legal but irrational at present. If, however, we substitute electricity for firewood and use the funds from selling this timber to subsidize hydropower departments and allow the workers to use the electricity free of charge, it would be rational but illegal. This requires policy readjustments.

4. Implement a policy of conserving coal to subsidize electricity.

All southern provinces now have policies for subsidizing coal. According to data provided by the Guangxi Autonomous Region, the state must provide subsidies of 3 million yuan for household coal used in the region. The state has set a coal subsidy of 8 yuan per ton for the coal used by urban residents of Zhaojue County in Sichuan. The Coal Construction Company calculated the actual subsidy at 44 yuan per ton of coal, so the county must provide subsidies of 50,000 yuan each year. For this reason, there also should be a policy of subsidizing electricity fees in the substitution of electricity for coal. We propose that in regions where electricity is substituted for firewood, the subsidy given for coal conservation should be used to subsidize electricity. This would not increase state fiscal outlays or increase the burden on the peasants.

5. We must develop and extend inexpensive, high efficiency energy conserving firewood substitution equipment.

According to surveys, most of the electric cooking utensils now used in regions supplied with electricity from small scale hydropower stations are low efficiency electric hotplates. This is due mainly to their low price. The price of cooking utensils that consume less and are more

efficient is more than three times higher, and it is hard for the peasants to buy them. This should be resolved by encouraging production departments to lower their costs and commercial departments to lower their profits. Surveys indicate that electric pots consume one-half the electricity of electric hot plates. The use of high efficiency cooking appliances would permit the number of households using them to double while requiring no increase in electric power. This is a sizeable figure.

Household electricity usage in rural areas occurs for only 5 to 6 hours a day. Regions without reservoir regulation also have 18 to 19 hours each day when a great deal of electricity is wasted. This is regrettable. The Liangshan Prefecture Water Conservancy and Electric Power Bureau and the Xichang City Science Commission have joined for trial manufacture of a type of "heat-saving electrically heated steam generator" that converts electrical energy during valleys into heat for storage. It is discharged during peak load periods to provide heat energy for production and household use, and it plays a highly efficient role in energy conservation. This equipment can generate 150 kilograms of steam per hour at a rated pressure of 7 kg/cm. The thermal efficiency is 94 percent and the maximum power is 150 kW. When used for 3 hours and 32 minutes before 6 or 7 o'clock in the morning, it consumes 374 kWh of electricity and can guarantee hot water supplies of a unit of bathing water, boiled drinking water, water sufficient to steam three meals and water for washing the feet for 200 people. The electricity is stored as heat energy during the night for use during the day. This plays a role in load regulation and electricity conservation within small scale hydropower networks and has obvious benefits. Too few of them are being produced now, however, and they have not been popularized in great numbers. The related departments should organize their production.

Industry also has some "wood tigers" that consume large amounts of firewood. The boiler at the Longshen County Distillery in Guangxi, for example, burns 4.5 million jin of wood a year, burning a mountain of wood each year. This is a very serious problem. The Lingzhou City Boiler Plant in Guangxi has developed a 0.2 ton/hour electric boiler, but the capacity is too small. Industry requires electric boilers capable of producing 1 ton/hour before they could play a role in firewood substitution. Development work in this area, however, has not yet been organized and gotten under way.

It is a law of human development that the use of electricity for cooking is an objective and inevitable developmental trend. Greater wealth in their lives means that they inevitably will demand higher standards of living. According to a survey in Guangdong Province's Pearl River delta region, an electricity price of 0.22 yuan/kWh has led to a popularization rate of more than 50 percent in the use of electricity for cooking. The economic development situation in the rural areas of China is very good at present. The developmental pace of electricity substitution for firewood should proceed more quickly in regions with fuel shortages. We should guide our actions adroitly according to circumstances to formulate the policies needed to promote healthy development of work in this area.

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